OPERATIVE THERAPEUSIS

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EDITED BY

ALEXANDER BRYAN JOHNSON, Ph.B., M.D.

VOLUME IV

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HERNIA

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VOLUME IV

CHAPTER I

HERNIA

ALEXIS V. MOSCHCOWITZ

INTRODUCTION

The mechanism of an operation for the radical cure of hernia is simple, requiring merely a correct knowledge of anatomy. An operation for hernia is readily learned, and, from a technical point of view, easily performed. A knowledge of technic is not, however, the only essential for success. Although every surgeon knows the steps of an operation for the radical cure of hernia, nevertheless, the number of recurrences varies widely; some surgeons have few, others have many, although both carry out the operation in practically the same way. Statistics showing the mortality rate and the number of recurrences are, as a rule, unreliable. A majority of these statistics are published either by individual surgeons or from individual clinics, in which cases the results obtained are infinitely superior to those obtained by a group of surgeons. Furthermore, many of these statistics refer only to immediate results; that is, recurrences are noted only if they occur within the usual time of 6 months, although it is well known that a large number of recurrences are noted after this period. Another factor that invalidates statistics is the floating character of the population, especially in large American centers, making it difficult to trace the final results of operations. Many surgeons delude themselves that they have very few recurrences because they do not see them; but human nature is such that an unsuccessfully operated patient does not, as a rule, return to the surgeon who originally operated upon him.

In order to be of value, statistics should obviate all these failures. In addition they should include not only the figures of selected men, or selected places, but also those of the occasional operator, or of surgeons of less experience. One surgeon will report 1 per cent. of recurrences, while another has 6 or 7 per cent. or more. Were the truth actually and fully known, I believe the percentage would be considerably higher.

It is generally conceded that some herniæ are absolutely incurable; but recurrences exist even among those that are, or at least ought to be, curable. When a surgeon is confronted with a recurrence in his own practice, he is apt to salve his conscience by excuses, preferring to ascribe the bad results to stretching of the tissues, fatty infiltration of the tissues, "poor qualities of the tissues," etc. Upon critical examination, however, the reason for recurrences will be found to lie deeper. These reasons will be more fully discussed later; suffice it to say, for the present, that, in my opinion, most recurrences are due either to the selection of a poor type of operation or to poor execution of a well-selected operation.

The conventional attitude of the vast majority of the surgical personnel of our hospitals toward cases of hernia is not conducive to the most intense study of this malady. Hernia may be described as an undramatic disease, not attended by any formidable mortality, and is, therefore, classed among the "uninteresting" cases. For this reason, a hernia is not carefully studied and the operation is hurriedly and mechanically carried out. It may appear trite to say that the study of hernia is deeper than is generally realized.

SURGICAL ANATOMY AND PATHOGENESIS

Hernia is mentioned in the oldest of medical books, and has received its due share of attention ever since. It has been a particularly favorite theme for anatomists, who have devoted much labor to the dissection of the various fascial and muscular planes involved. It is true that many of these finer structures are not dissected out in operations for hernia; nevertheless, their anatomy must be known in order to understand the principles underlying a well-executed operation. The oft quoted *bon mot* of a surgeon of the last century, who advised in strangulated hernia "to cut through all the Latin names and get down to the gut" is good wit, but, to modern tastes, poor surgery.

Most anatomical text books devote sufficient space to the description of the parts in question; a sufficient knowledge of the descriptive anatomy of the various structures is, therefore, presumed. There are, however, certain fundamental principles to which attention must be called; as it is only by a thorough grasp of these that the "natural history" of a hernia, so to speak, can be properly understood. Most of these principles may appear elementary, yet it is singular that their importance is not more generally appreciated.

1. **Peritoneal Sac.**—The abdominal parietes are lined by peritoneum. The only exceptions are a few isolated areas to which the suspensory ligaments of the viscera find attachment. This parietal peritoneum is pushed outward when a viscus escapes from the abdomen, and therefore constitutes the sac of the hernia. There are, in addition, certain sacless forms of hernia (see Sliding Hernia), but these arise only under very exceptional conditions.

2. Properitoneal Fat.—Anatomical text books describe the layer external to the peritoneum as "properitoneal fat." Descriptions of this layer are very meager and give the impression that it exists as a well-developed layer throughout the entire extent of the peritoneum. This is entirely erroneous. It is present on the anterior aspect of the abdomen in but few places, i. e. where either viscera or their suspensory ligaments find attachment; we mention, for instance, the bladder and the area embraced by the suspensory ligament of the liver. Hardly any properitoneal fat exists under the recti muscles except where the suspensory ligament of the liver or the bladder finds attachment. Properitoneal fat is rarely, if ever, encountered at the point of exit of an oblique inguinal hernia. This fact is so constant that the presence of properitoneal fat in an operation for inguinal hernia should serve as a warning of an abnormality—for example, the presence of the bladder. Failure to heed this warning has not infrequently been followed by injuries to the bladder.[1]

3. The Transversalis Fascia.- External to the peritoneum, and separated from it only by a more or less developed (or in some parts entirely absent) layer of "properitoneal fat," there is a very dense fascia, known as the "intra-abdominal fascia." This fascia has received different names, according to its anatomical location; e. g. the diaphragmatic fascia, lining the diaphragm; iliac fascia, lining the iliac fossæ; pelvic fascia, lining the pelvis; transversalis fascia, lining the transversalis muscle, etc. It is unfortunate that these various names have become prevalent, because the diversity of nomenclature tends to obscure an otherwise simple matter. It must never be forgotten that this fascia forms one continuous layer. For the sake of simplicity the writer shall adhere, in this article, to the name "transversalis fascia."

The transversalis fascia is very dense and strong, but is stronger in some regions than in others. The strength of the transversalis fascia is of the greatest importance to the human economy, because at some areas of the abdomen it is to all intents and purposes the sole protective structure, and yet it serves its purpose so excellently that hernia at these points is of rare occurrence.

In some parts of the abdomen, on the other hand—for instance, over the diaphragm—this fascia is weak, very probably because no great demands are ever made upon it.

4. All the great vessels of the posterior abdominal wall lie upon the transversalis fascia, and are covered by the peritoneum. This fact is of fundamental importance to the proper understanding of the pathogenesis of every variety of hernia; and, unless it is fully grasped, all subsequent explanations are unintelligible.

---

[1] The cases of so-called "Fettbruch," "fat hernia," "hernie grasseuse" and "hernia adiposa" that have been reported (with or without a sac), are in my opinion hernial protrusions of the fat which fills the space of Retzius, and are commonly accompanied by an extraperitoneal bladder hernia. This fat may increase unduly, and may form quite an appreciable tumor (Friedman, 16).

Figure 1, A represents diagrammatically the relation of the vessels to the transversalis fascia and peritoneum at any point above the bifurcation of the aorta. For the sake of simplicity only the arteries are represented.

At the point of exit of the femoral vessels into the thigh the diagram is modified as in Figure 1, B.

Figure 1, C is a modification of Figure 1, B and represents similarly the exit of the spermatic vessels.

If Figures 1, B and 1, C are examined, it becomes evident that, at the point where the vessels lose their relationship to the peritoneum, there is an opening in the transversalis fascia in order to permit the escape of these vessels from the abdomen. If there were no opening, the vessels could obviously never escape to the thigh or testis. Now this opening in the transversalis fascia is of the greatest importance to every hernia, for through it the hernia first escapes. In oblique inguinal hernia it is called the "internal inguinal ring"; in femoral hernia it is called the "internal femoral ring"; such an internal ring exists in every hernia.

This internal ring has been variously described by different anatomists. Its importance has always been appreciated, but the most important thing to remember is this: that it is merely a hiatus or hole in the transversalis fascia, and *only* in the transversalis fascia. The ring is surrounded, covered by, and lies in close proximity to other structures, but as a hole it exists only in the transversalis fascia. Were this hole not present in the transversalis fascia, the hernia could not occur at that particular site.

This hole, or internal inguinal ring in the present instance, can best be demonstrated from within the abdomen by raising the parietal peritoneum away from the transversalis fascia, thereby exposing the spermatic vessels as they enter the ring. It is slightly more difficult to demonstrate this structure by dissecting from without inward, because it is then necessary to make an artefact. The reason for this is that nature has put a nicer finish to this hole. Careful dissection will show that the transversalis fascia is continued downward for a certain distance upon the vessels, gradually becoming thinner and thinner, and finally blending with the wall of the vessel itself. To be exact, therefore, the last 2 diagrams should be modified as in Figures 1, D and 1, E.

Now in certain areas these perivascular prolongations of the transversalis fascia have been carefully studied, are well marked, and, indeed, have received special names. We mention, for instance, the prolongation upon the spermatic vessels, which is called the "infundibuliform fascia"; and the prolongation upon the femoral vessels, which is called the "sheath of femoral vessels."

These various prolongations have no intrinsic value as far as the curability of a hernia is concerned; but they are vastly important, not only to explain one of the important coverings of a hernia, but also its pathogenesis.

Although attention has not been called to this point before, I have no doubt

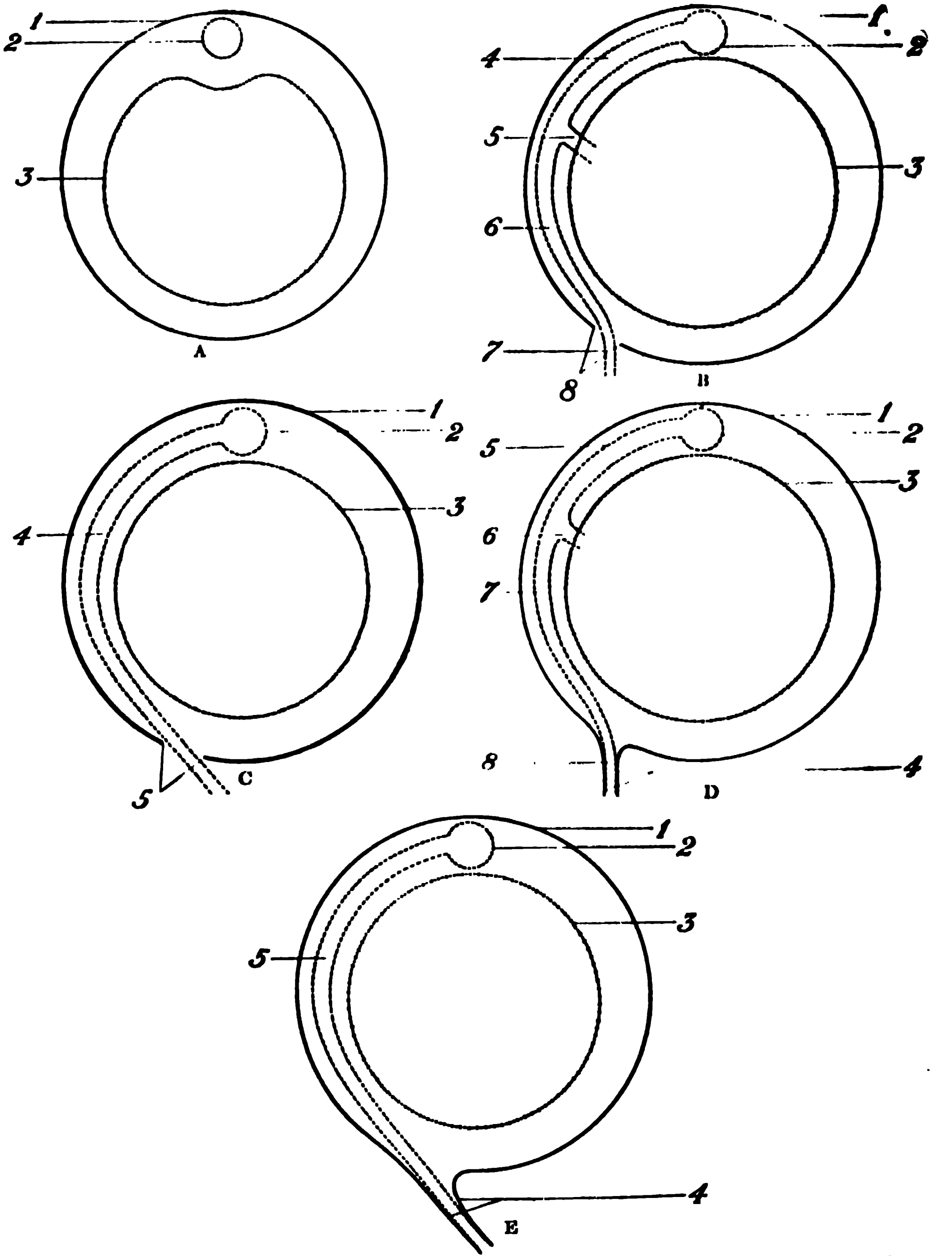

FIG. 1.—DIAGRAMMATIC CROSS-SECTIONS OF THE ABDOMEN. 1, Transversalis fascia; 2, aorta; 3, peritoneum. A—At any level above the bifurcation of the aorta, showing the relations of tho aorta to the peritoneum and transversalis fascia. B -Showing the relations of the aorta, common, external and internal iliac and femoral arteries to the peritoneum and transversalis fascia. Noto the hole (8) in the transversalis fascia, through which the external iliac artery escapes to the thigh. 4, Common iliac artery; 5, internal iliac artery; 6, external iliac artery; 7, femoral artery. C—Showing the relations of the aorta and spermatic artery to the peritoneum and transversalis fascia. Note the hole (5) in tho transversalis fascia, through which the spermatic artery escapes to the testis. 4, Spermatic artery. D—Showing the relations of the aorta, common, external and internal iliac and femoral arteries to the peritoneum and transversalis fascia. Note the outward prolongation of the transversalis fascia upon the femoral artery, forming tho so-called "sheath of the femoral vessels" (4). 5, Common iliac artery; 6, internal iliac artery; 7, external iliac artery; 8, femoral artery. E—Showing the relations of the aorta and spermatic artery to the peritoneum and the outward prolongation of the transversalis fascia upon the spermatic artery, forming the so-called "infundibuliform fascia" (4). 5, Spermatic artery.

that a similar anatomical arrangement holds true for every blood-vessel that escapes from the abdomen to the periphery—for instance, the obturator and sciatic arteries, or the umbilical vein and arteries. Likewise a similar prolongation of the transversalis fascia accompanies all viscera that escape from the abdomen—for instance, the rectum and vagina—this fact accounts for the occurrence of hernia even in these locations. In this connection attention is called to the fact that the nerves are not accompanied by such prolongations of the transversalis fascia. The nerves are situated behind the transversalis fascia; this can be illustrated best in a diagrammatic cross-section of the obturator canal, in which the relationship of the parts exists as illustrated in Figure 2, A and not as might be assumed in Figure 2, B. This is a point of minor importance, but should be known.

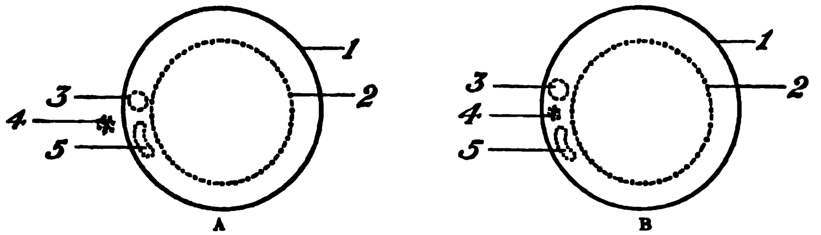

FIG. 2.—DIAGRAMMATIC CROSS-SECTIONS OF THE OBTURATOR CANAL AND CONTENTS.

A—Correct section. Note that the obturator nerve is outside of the transversalis fascia. 1, Transversalis fascia; 2, peritoneum; 3, obturator artery; 4, obturator nerve; 5, obturator vein. B—Incorrect section. Note that the obturator nerve is presented to be inside of the transversalis fascia. 1, Transversalis fascia; 2, peritoneum; 3, obturator artery; 4, obturator nerve; 5, obturator vein.

It is an established truth that the transversalis fascia, as a rule, is strong enough to retain the viscera within the abdomen. However, it is not strong enough to do so within certain definite anatomical areas, and it is at these areas, and at these areas only, that herniæ occur. A little reflection will show that herniæ occur only where blood-vessels or viscera normally make their exit. In other words, it is apparent that these weak anatomical points are the attenuated perivascular or perivisceral projections of the transversalis fascia. Every hernia can, therefore, be diagrammatically represented as in Figures 3 and 4.

A general impression prevails that the muscles of the abdominal wall are important factors in the prevention of hernia. This view, in my opinion, is without any foundation whatever. It is agreed that the abdominal muscles unquestionably prevent undue general bulging of the abdomen; but that they prevent the escape of the abdominal contents in the form of a hernia I would absolutely deny. It is the fascia, and not the muscles, that prevents hernia. The arguments to support this contention are the following:

(a) Hesselbach's triangle is the space bounded below by Poupart's ligament, externally by the deep epigastric vessels, and internally by the conjoined tendon and edge of the rectus muscle. Its floor is the transversalis fascia, behind which are properitoneal fat and peritoneum. In other words, this triangle is devoid of all muscle protection; nevertheless, hernia through this triangle is quite rare. On the other hand, the space situated to the outer side of the deep epigastric artery, which is covered by both the internal oblique and transversalis muscles, and aponeurosis of the external oblique, is the point of exit of the exceedingly common oblique inguinal hernia.

(b) In anterior poliomyelitis occasionally groups of muscles become paralyzed, degenerate, and entirely lose their function. Nothing prevents the viscera from escaping except the transversalis fascia and peritoneum. Nevertheless, a true hernia never occurs; merely a slight bulging. Baracz (3) calls these cases "pseudo-herniæ."

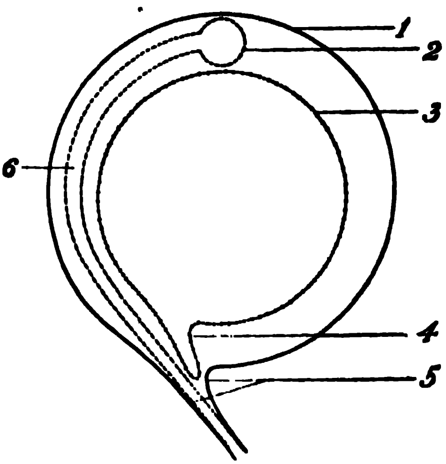

Fig. 3.—Diagram Illustrating an Incipient Inguinal Hernia. 1, Transversalis fascia; 2, aorta; 3, peritoneum; 4, sac of an inguinal hernia; 5, infundibuliform fascia; 6, spermatic artery.

(c) In order to effectually disprove the long-accepted hypothesis of the great importance of the muscles in preventing or curing a hernia, I have performed, in a series of perhaps 25 consecutive cases, the following operation for the radical cure of inguinal hernia. All the steps were exactly those of the Bassini or Ferguson operation, excepting that no suture of the muscles was done. Instead, the upper edge of the aponeurosis of the external oblique was sutured to Poupart's ligament; the lower edge of the aponeurosis was sutured on top of this. With the exception of 1 case, which was that of a sliding hernia, a type notoriously hard to cure, every one of these cases was radically cured.

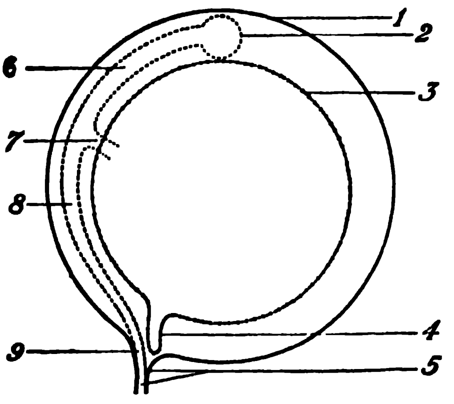

Fig. 4.—Diagram Illustrating an Incipient Femoral Hernia. 1, Transversalis fascia; 2, aorta; 3, peritoneum; 4, sac of a femoral hernia; 5, sheath of femoral vessels; 6, common iliac artery; 7, internal iliac artery; 8, external iliac artery; 9, femoral artery.

(d) A striking example of the capacity of a fascial stricture to retain organs within a cavity is seen after certain operations upon the brain. No matter how large the trephine opening, the brain will not prolapse. The moment, however, that we incise the dura, a hernia of the brain ensues. Indeed, all our decompression operations depend upon this principle.

These are the principles underlying the pathogenesis of hernia in general. It is needless to add that the more intimate anatomy varies with every form of hernia; this will be discussed later.

Theories of Hernia Causation.—Assuming this theory to be correct, and assuming, also, that the anatomy of the human individual varies but slightly, the question arises, why do some people acquire a hernia, and others not? To answer this, we enter a contentious field. The reasons are manifold, and as yet are not fully clear.

The *congenital* or *saccular theory* has many adherents, and is alluring. At the same time it is faulty, because it does not explain all forms of hernia. According to this theory all inguinal herniæ are due to faulty closure of the "processus vaginalis peritonei," i. e. that process of the peritoneum which accompanies or precedes the testis in its descent to the scrotum. No one denies the incidence of a hernia when the vaginal process has never become obliterated; this variety, however, forms only a small percentage of all herniæ. To explain the common types of inguinal hernia, Russel, Murray, and their followers assume an imperfect closure of the processus vaginalis. The process has become completely obliterated in the lower part, but the upper part persists and forms the starting point of a hernia. Definite proof of this contention is lacking. Indeed, I am able to submit an observation that negatives this contention. If the sac of an acquired inguinal hernia were of congenital origin, we should expect it to be connected at its distal extremity with the fibrous cord-like structure that persists after obliteration of the distal part of the processus vaginalis. As a matter of fact, this adhesion is found only in that very rare anomaly known as "infantile hernia." The oft-quoted autopsy reports in which, particularly in young infants, smaller or larger peritoneal dimples are found, are by no means convincing. Who will presume to say that those dimples are congenital remains of the processus vaginalis or acquired hernial sacs?

Another objection to the saccular theory is that it does not explain all varieties of hernia. In femoral, obturator, or sciatic hernia no structure analogous to an obliterated processus vaginalis is genetically possible.

Murray (53, 54) submits many arguments to support the congenital saccular theory for femoral hernia also, and for the other varieties of hernia as well. None of these arguments are, in my opinion, absolutely convincing. No one can deny the possibility, or even the probability, of congenital saccules in the inguinal (Hansen, 23) and umbilical regions; but to make the broad statement that all herniæ are caused by congenital sacs is, in the light of our present knowledge, unwarranted.

It is simpler to negative a theory than to propound a better one. I have already pointed out the existence of certain weak areas in the transversalis fascia. When perfect balance exists between the force of intra-abdominal pressure and the resistance of these weak areas in the abdominal wall, no hernia occurs. When, however, the intra-abdominal pressure is increased, or the transversalis fascia is weakened, either by disease or some other factor, this balance is disturbed and a peritoneal dimple is pushed out. Soon a portion of the omentum finds lodgment within this dimple; the sac becomes larger, more abdominal contents enter the sac, and a fully developed hernia results. This theory is simple, explains all herniæ, and accords with clinical data.

In its incipiency, therefore, the hernia consists only of 2 layers, the peritoneum and the perivascular prolongation of the transversalis fascia. In its subsequent development the hernia becomes covered by all the structures which it pushes ahead. Knowing, therefore, through what structures the hernia must pass, it is easy to reconstruct the coverings of a particular hernia.

Take, for example, an oblique inguinal hernia. The earliest hernial covering is the peritoneum; this, therefore, is the first layer; next comes the perivascular prolongation of the transversalis fascia, which, therefore, is the second layer. In its downward progress the hernia meets the transversalis and internal oblique muscles, or rather specialized portions of these structures known as the "cremaster muscle," and the thin fascial layer which holds the fibers of this muscle together, known as the "cremasteric fascia." These structures, therefore, must form the third layer.

In small sized herniæ, that is, those which have not yet escaped from the external inguinal ring, these 3 layers are the only coverings of the hernia. The moment the hernia has escaped from the external inguinal ring, it derives a covering from those fibers of the aponeurosis of the external oblique that bind together the columns of the external inguinal ring, namely the "intercolumnar fascia." This, therefore, is the fourth layer.

Thereafter the hernia proceeds into the scrotum, and derives coverings only from the skin and its appendages, namely the superficial fascia fifth, subcutaneous fat sixth, and skin, seventh layers.

Similar deductions as to the coverings can be made for herniæ of all varieties.

Conclusions.—Assuming the theory to be correct, that the transversalis fascia is the sole important structure needed to retain the viscera within the abdomen, it becomes manifest that, in order to cure a hernia, the only procedure necessary is to close the hole in this fascia. Unfortunately this is impossible in a majority of herniæ, because of the importance of the blood vessels which pass through this hole. The conclusion follows, that a radical cure of the most frequent forms of hernia, namely oblique inguinal and femoral, is entirely impossible in the strictest anatomical sense, because, no matter what we do, the hole in the transversalis fascia, through which the spermatic or femoral vessels pass, still remains. We may dislocate the hole, we may make a new exit for these vessels, but the hole is still there. In practice, however, we find that the surgeon gets around the difficulty, although he must ignore the weak spot in the transversalis fascia, by fortifying this hole, building a buttress of fascial or muscular structures in front of the opening. How far he succeeds will be discussed later.

METHODS OF TREATMENT OF HERNIA

The discussion of the treatment of hernia may be divided into 3 subdivisions:

I. Prophylactic.
II. Palliative.
III. Radical.

I. PROPHYLACTIC TREATMENT

It has already been pointed out that the pathogenesis of hernia depends upon two factors: (1) weakness of certain portions of the abdominal wall; (2) increased intra-abdominal pressure.

If there is a weakness of the abdominal wall, little or nothing can be done to strengthen it by prophylactic measures. Much, however, can be done to obviate sudden or continued increase in the intra-abdominal pressure. The treatment of the various conditions that may give rise to increased intra-abdominal pressure is out of place here; we shall merely mention the names of some of the most important maladies: phimosis, stone in the bladder, whooping-cough, diseases of the respiratory tract, habitual constipation, and long-continued diarrheas.

II. PALLIATIVE TREATMENT

By palliative treatment we refer to the placing of artificial external barriers in front of the opening through which the hernial contents escape. These barriers act upon the principle that a pad, varying in shape and size, is firmly held against the opening by means of springs or elastic bands. Such artificial bands with their pads are called "trusses."

It is necessary that every surgeon be well acquainted with the application of trusses, because even the most radical surgeon must occasionally recommend their use.

It cannot be denied that the wearing of a truss will in rare instances be followed by a radical cure; but this is of such exceptional rarity as not to merit serious consideration. It is self-evident that no radical cure of a hernia is possible unless the sac is either extirpated or obliterated. It can be conceived that the pressure of the truss may cause so much trauma to the endothelial lining of the peritoneal sac as to cause agglutination of the walls, but such a possibility manifestly must be very rare.

So-called cures or apparent cures are accounted for in one of two ways. Let us assume, for instance, a case of congenital inguinal hernia in a young child. A truss is applied for a number of years, and is then discarded. Such a patient may be cured because the normal obliteration of the processus vaginalis has been completed; or the cure may be only an apparent one. After a number of years the hernia again makes its appearance, and if such a patient is operated upon a congenital sac is then found.

It is not within the scope of this article to describe the various kinds of trusses, their method of manufacture, the advantages of one over the other, etc. It is sufficient for our purpose to point out the fundamental principles which underlie the application of trusses.

A *sine quâ non* for the application of a truss is the complete reducibility of all the hernial contents. If a reduction of the hernial contents is impossible, the application of a truss is absolutely contra-indicated; not only because it is useless, but also because it may actually do considerable harm. A truss in such instances may cause considerable pain, and may give rise to saccular adhesions. Despite this contra-indication, we have seen this rule frequently violated.

It is not sufficient to send a patient afflicted with a hernia to an instrument- or truss-maker, or, what is worse still, to the corner druggist with directions to buy a truss. Full directions as to the variety of the hernia, for instance whether direct or indirect, whether femoral or inguinal, must be given. I have often seen femoral trusses worn over an inguinal hernia, and vice versa.

It is the surgeon's duty to see that the pad is applied directly over the hole in the transversalis fascia. For example, in oblique inguinal hernia, it is folly to apply the pad over the external inguinal ring; the opening is at the internal inguinal ring, and it is there that maximum pressure should be applied.

Furthermore, the surgeon should make certain not only that the truss retains the hernia when the patient is standing quietly, but also that it does not shift on sitting or lying down, in rapid walking or in walking up or down stairs.

Not only the pad, but also the spring of the truss, should be carefully examined in order that undue and unnecessary pressure may not be exerted.

The question whether a truss should be worn at night is not so readily answered. I believe it preferable that the truss be worn at all times; in young children, in whom a radical cure is attempted by this method, this is absolutely essential. In adults with small herniæ which do not readily prolapse, the wearing of a truss at night, if it becomes too irksome, is not of such importance.

When the truss is first applied, the skin of the inguinal region readily becomes chafed; daily washings with alcohol, dusting with talcum powder, and attention to cleanliness will obviate this. It is preferable that the truss be worn against the naked skin, but the interposition of a layer of old linen may be allowed.

To the experienced surgeon there are no strict indications for the use of *trusses, excepting cases in which an operative cure is distinctly contra-indicated (see page 13).*

It is important that the surgeon explain to the patient who desires to wear a truss, that this treatment is merely symptomatic, and excepting in isolated instances, so rare, indeed, as to be hardly worth considering, is in no sense of the word curative.

For the sake of completeness we add that in cases of extremely large herniæ the wearing of bags, fashioned upon the style of gigantic suspensories, may be necessary in order to support the hernia.

III. RADICAL TREATMENT

The radical treatment of hernia again may be subdivided into the following methods.

1. Radical Cure by Truss

The rare instances in which a truss may be curative have already been mentioned.

2. Injection of Irritants

Methods in which the aim is to induce an obliteration of the hernial orifice and sac by producing an adhesive inflammation. Prior to the introduction of antisepsis into surgery, physicians produced such adhesive inflammations by the injection of irritating substances, such as iodin, alcohol, zinc chlorid, etc., by means of a hypodermic syringe. An infusion of oak bark was in vogue for a long time. It was the aim of the operator to inject these substances around the neck of the sac; but how frequently they really succeeded in so doing, without penetrating the serosa, is a debatable matter. Indeed, it is very probable that the few isolated cases of cure were due to the fact that these irritating substances penetrated the serosa, and caused complete obliteration of the sac. A radical cure but very rarely followed. In addition, the danger of peritonitis was considerable, due either to irritation or to septic material introduced through the syringe or resulting from puncture of the intestine. Cases of gangrene have also been reported. This method has properly been abandoned.

3. Injection of Paraffin

In the '90's of the last century the method of injecting paraffin enjoyed considerable popularity. Paraffin is a perfectly bland, non-irritating substance, sterilizable by heat, and when once injected subcutaneously, causes no great harm, as a rule. The object of this method was to produce the formation of a species of subcutaneous pad over the hernial orifice. It was the aim of the operator to inject the paraffin in and about the neck of the sac, thereby causing a constriction which was supposed to prevent the descent of hernial contents. The advantage of this method over the operative was that it could be carried out in ambulatory patients. Its disadvantages were, however, so numerous as to outweigh this slight advantage. The possible dangers are these: (1) injury of the gut; (2) the occasional formation of tumors, so-called paraffinomata, which are unsightly and may cause pain; (3) the cure is not radical. Even assuming that the injection was perfectly made, the sac still remained and communicated freely with the peritoneal cavity, so that the patient was still the possessor of at least a potential hernia.

4. Operative Treatment

Indications and Contra-indications.—In modern surgery the dangers of an operation upon a simple and uncomplicated hernia are negligible; moreover, the prospect of a radical cure is so good that the patient's own desire to be operated is already a sufficient indication.

A discussion of the contra-indications is more pertinent; and as we shall see, these are few.

1. All systemic and infectious diseases, such as florid syphilis, acute pulmonary tuberculosis, etc.

2. All acute infectious diseases are a temporary contra-indication for a radical operation.

3. Very early infancy is looked upon as a contra-indication to the radical operation. Formerly, it was the rule never to operate upon children under 3 years old. Gradually we are accustoming ourselves to operate at an earlier age, and at present it is not uncommon to attempt a radical cure of a hernia at the age of a year and a half and even earlier. The only danger, especially in the commonest form, oblique inguinal hernia, is the danger of infection from urine or feces. But, as a rule, urine is sterile in young infants, and I have never seen infection of a hernial wound, even when the urine saturated the dressing. Infection from the feces can be guarded against by appropriate posture, bandage, care, and watchfulness.

An important consideration is the social status and surroundings of the little patients. The wealthier classes have the time and can afford the necessary attention to give the truss treatment a full trial. Among the poorer classes no good comes from truss treatment, and the indications for such treatment are becoming more and more restricted.

4. Very advanced age must be looked upon as a contra-indication for a radical cure. The term "very advanced age" is also an elastic one; it must not be forgotten that some individuals are old at 40, while others are still young at 70. Old age in itself is in reality no contra-indication, but it should be remembered, in spite of weighty opinions to the contrary, that in the aged the

reparative functions are certainly below par. The great danger is the tendency of the aged to suffer from postoperative respiratory complications.

5. Particular attention is to be paid to all diseases of the respiratory tract. Cases of chronic emphysema and chronic bronchitis, etc., should be excluded from operation. The same is true for uncompensated valvular lesions; if the compensation is good, a radical cure may be undertaken, should the hernia be irksome to the patient.

6. Diabetes is a contra-indication only in so far as it makes extraordinary demands upon the maintenance of the strictest asepsis. While at the present time perfect aseptic healing is practically the rule in all hernia operations, it must not be forgotten that slight infections occasionally happen. To individuals in good health, such slight infections are of no practical consequence; but in the blood of diabetics the abnormally high glucose content offers such a splendid culture medium to bacteria which have gained entrance, as to cause very grave, and sometimes even fatal consequences.

7. Chronic nephritis is a contra-indication because the afflicted individuals are not good surgical risks for a general anesthesia. If the nephritis is not very bad, and the hernia is very irksome, an operation under local anesthesia may be considered.

8. All complicating diseases of sufficient gravity are contra-indications.

9. I have often been confronted with the question of operating upon a hernia in the presence of an acute gonorrhea, and have invariably refused to do so. The reasons are, that, in a large majority of hernia operations, there frequently arises postoperative retention of urine, requiring catheterization; it is preferable not to introduce instruments through an acutely infected urethra.

10. For the reason that catheterization may be extremely difficult, or even impossible, a tight urethral stricture is a contra-indication. It is preferable to first cure the stricture; after this has been accomplished, the hernia operation may be performed.

11. It is very important that the integument covering the operative field be in a healthy condition. All inflammatory diseases of the skin in the region to be operated upon, e. g. acute eczemata, psoriasis, acne pustules, etc., are, therefore, temporary contra-indications to operation. It will be shown later how important the factor of perfect asepsis is in promising a radical cure.

12. Contra-indications referable to the hernia itself arise only in connection with extreme size. Neglected herniæ may occasionally attain such enormous proportions that practically the entire intestinal tract is in the hernial sac. It has been aptly said of these herniæ that the hernial contents have lost their right of domicile in the abdomen. Even when reduction is possible, which is rare, the sudden refilling of the peritoneal cavity is apt to cause embarrassment to the respiration and heart action. Much may be done, even in these cases, by preliminary reduction cures, in order to decrease the size of the omentum, and by gradual replacement of the hernial contents. In

Trendelenburg's posture the gradually reduced viscera stretch the abdominal walls, so that they can again accommodate the intestine.

Thus far only the more important contra-indications to an operation for hernia have been mentioned; there are undoubtedly many more. In this connection the importance of a thorough physical examination of every patient prior to the operation must be emphasized. It is surprising how frequently the careful surgeon finds a contra-indication to operation.

Important as the contra-indications to an operation for a radical cure are, there is still one more important indication that must be mentioned. We refer to cases of strangulated hernia in which taxis has been unsuccessful; then the indication for immediate and urgent operation is absolute. In the presence of a strangulated hernia, there are no contra-indications whatever to operation.

Preparation of the Patient.—In former years the preparation of the patient for operation was considerably overdone. Slowly, the routine treatment has become materially simplified. Most of the disinfection is now done in the operating room itself, so that very little preliminary treatment is required. At most a mild laxative, preferably castor oil, is administered on the evening preceding the operation and a low soapsuds enema is given on the morning of the operation. The abdomen is shaved for a liberal distance around the site of the operation.

Choice of Anesthetic.—It is entirely out of the scope of this article to discuss the merits of any particular anesthetic. The choice of this must be left to the surgeon.

Of far greater importance is the question of choice between general and local anesthesia. Considerable discussion has recently centered around this point. Some of the advocates of local anesthetics have stated their convictions with enthusiasm; but it does not appear that local anesthesia has gained much headway, and for the present, at all events, the advocates of a general anesthetic are decidedly in the majority. No one can deny that it is possible to anesthetize the greater part of the operative field of a hernia sufficiently to render the operation comparatively painless. It appears to me, however, that there is a great deal more to be considered in a radical operation for hernia than the mere painlessness of the operative field. The various steps to be gone through must be done so exactly that a failure to carry out correctly the smallest detail may completely mar the result. My views are perhaps strong upon the subject, but I have no hesitancy in stating that no one, not even the most perfect expert in the use of local anesthesia, can undertake the various steps of the operation as carefully as he would, were the patient under a general anesthetic. In the presence of some pain, all of us are apt to slur, perhaps just a trifle; and the smallest deviation may decide the question between success and failure. Furthermore, there are certain parts of the operative field—for instance the pubic attachment of Poupart's ligament, or the neck of the sac—which are particularly difficult to anesthetize locally; and yet the former must be exactly sutured, while the latter must be completely isolated and ligated high up, in order to insure a radical cure.

Another point that must be considered, even though it is apparently a trivial one, is that the success of a local anesthetic depends greatly upon the nationality, and, in consequence, the temperament of an individual. The Latin races and the Jews are not subjects that tolerate operations under local anesthetics well. I have seen patients operated upon by acknowledged experts in local anesthesia, who came to secondary operations and absolutely refused operation under local anesthesia. Physicians who have been operated on under local anesthesia for hernia agree they would not pass through the ordeal again.

Furthermore, if it is considered that in the majority of cases the radical cure of hernia is undertaken only in individuals in the best of health, to whom the danger of an anesthetic is slight, I see no reason for withholding it.

I do not wish to deny all good to local anesthetics. I value local anesthesia highly and use this method extensively. I wish merely to define its limitations in operations for hernia. To sum up, local anesthesia should only be used in operations for hernia when a general anesthetic is contra-indicated. Local anesthesia has its special field of usefulness in certain cases of strangulated hernia where less attention is paid to the radical cure and more toward saving life.

There is still another form of anesthesia which must be referred to, namely, spinal anesthesia. Spinal anesthesia has a large number of followers on the continent of Europe; but, with few exceptions, it has not been adopted by American surgeons as a routine procedure. It cannot be denied that, as far as painlessness and ease of operation are concerned, spinal anesthesia is particularly efficacious in hernia operations. The anesthesia is perfect, as a rule, and is generally of ample duration; so that even a bilateral hernia can be operated upon with the greatest of ease. But there is one great objection; the method is not safe. Its mortality is considerably higher than that of either ether or chloroform narcosis, and for this reason it has not been recognized as a standard method of inducing anesthesia. Hohmeier and Koenig (26) collected statistics of 2,400 spinal anesthesias embracing 41 of the largest clinics of Germany, and have arrived at the conclusion that it cannot be considered as a method of choice and should be restricted to very exceptional cases.

Methods of Sterilization.—The results, as far as the aseptic healing is concerned, are excellent with the Grossich method of iodin disinfection. The results with the method to be described have been so good, however, that I am loath to abandon it. It has undoubtedly certain disadvantages as compared with iodin disinfection. It consumes more time; it requires an additional assistant; and it is more expensive. The great disadvantages of the iodin method are that it occasionally gives rise to an annoying dermatitis; and, above all, infections, in my experience, occur more often with the iodin method than with the older method. I am safe in saying that with the older method I have seen less than 1 per cent. of infection in the past years; and of this 1 per cent. I recall but one case in which the deep sutures were infected; in other words, the infection had absolutely no effect upon the postoperative course or upon the cure.

The method is simple. The parts are thoroughly washed with green soap and water by means of a towel (we have abandoned brushes during the past 5 years). The field is wiped off with a towel. This is followed by alcohol, then ether, and finally by 1 : 500 $HgCl_2$ solution. If operating near the genitals, as in inguinal or femoral hernia, the penis is wrapped in a compress of iodoform gauze fastened by a rubber band.

Essentials of the Operation for the Radical Cure of a Hernia.—The importance of the transversalis fascia, the formation of hiatuses in this fascia by the exit of blood-vessels, and the localization of hernia at these areas have already been discussed. Predicating these propositions, it would follow that to cure a hernia all that is necessary would be to tie the blood-vessels between 2 ligatures, to replace the proximal stump, and to close the hole in the transversalis fascia. Unfortunately such a procedure is not feasible, because in a vast majority of herniæ the blood-vessels, which are the fundamental cause of the trouble, are of vital importance to the structures which they supply. The preservation of these blood-vessels is, therefore, of paramount consideration in the cure of a hernia. The hole through which the vessels pass may be dislocated by the operation, but whatever type of operation is done, the hole still remains. It follows, therefore, that, on theoretical grounds at least, no hernia is curable. In practice, however, we know that most forms of hernia are curable. It behooves us, therefore, to analyze our operations, in order to see which of the various steps of an operation is the essential one.

1. Excluding sliding herniæ, the essential step in the radical cure is the proper ligation of the sac. This is such an important point that it will require detailed discussion. Suppose, for the sake of argument, that the surgeon performs a very extensive, very firm, and very complicated plastic operation, but fails to extirpate the sac. Would it be reasonable to assume that the patient so operated upon has any chance for a radical cure? Most certainly not!

Let us assume, on the other hand, that the surgeon extirpated the sac completely, and allowed the muscles, fasciæ, etc., to remain as they were. I have no hesitancy in saying that many such cases would be cured. In truth, there are some operators who report excellent results from this simple procedure alone; results so good that they vie with other procedures of established repute. Let us take, for example, Kocher's "Verlagerung's Methode" in inguinal hernia; while apparently a complicated procedure, this operation, in the last analysis, accomplishes nothing more than a complete obliteration of the sac; nevertheless, Kocher and his followers report a percentage of cures, which is nearly as high as that attained by the Bassini methods.

I have reoperated a number of cases in which only plastic operations were done, without ligation of the sac, the surgeon believing that the sac was so small as not to be worth while extirpating. This sort of operation is not uncommonly done in double herniotomies, where one side is operated in the conventional manner, with ligation of the sac, while the other side is treated prophylactically, as it were, a plastic operation being done without ligation of the sac. The latter hernia invariably recurs and a large sac develops.

A similar circumstance is noted in cases of associated direct and indirect inguinal hernia; one of the sacs is likely to be overlooked, or is not even searched for. The hernia invariably recurs.

Cases are not infrequent in which the sac is incompletely extirpated, leaving a small dimple behind. This is an error which avenges itself by very prompt recurrence.

The proper mode of extirpation of the sac will be discussed elsewhere (page 29). It is sufficient to say, for the present, that in all cases the sac is to be ligated and extirpated completely without leaving a trace of a dimple.

2. *It has already been stated that, on theoretical grounds at least, hernia is an incurable disease; yet the cure of hernia is perhaps one of the greatest blessings and advances of modern surgery.* The question now arises: How may these two apparently contradictory statements be reconciled? In a well-conducted operation, the hiatus in the transversalis fascia persists, but the surgeon fortifies this hiatus by building a buttress in front of it. This buttress consists, as a rule, of muscular and fascial structures situated in the neighborhood, which are dislocated and fastened in such a manner as to form an effective barrier in front of the opening. This is one of the cardinal principles underlying the modern treatment of hernia. The manner in which the buttress is made varies with each variety of hernia and will be discussed later in detail. It is almost unnecessary to add that the buttress must be made in such a manner as to remain permanent. It is not sufficient to go through certain steps and have a beautifully finished operation. Many a "cure" on the operating table is followed by recurrence, because the muscles and fasciæ composing the buttress in time resume their original relations.

These two points are the only essentials in the radical operation of any hernia. There are other factors, but these are only minor ones and only aid in fulfilling, to the best advantage, these two principles.

Instruments and Suture Material.—The instruments used in the radical cure of a hernia are so simple that it is not necessary to describe or enumerate them.

Of far greater importance is the suture and ligature material. For ligatures we give preference to dry iodin catgut, both for ligating vessels and for ligating the neck of the sac. We have used dry iodin catgut, prepared according to our method (43, 44, 45) in thousands of cases; it continues to give perfect satisfaction, and we do not see the slightest reason for abandoning it.

Opinions are widely divergent as to the choice of the suture material. On the continent of Europe most clinics use silk both for sutures and ligatures. American surgeons, on the contrary, use catgut prepared by various methods, practically to the exclusion of all other suture material.

For the plastic work of a hernia operation, chromicized catgut appears to be the favorite suture material in America. Up to about 2 years ago, I also used chromicized catgut. At that time a frequent observation led me to abandon chromicized catgut for plastic work in hernia. I have operated on a large number of recurrences, the result of operations made both by myself and others, whose technic cannot be impeached. I found that in nearly all in whom chromicized catgut was used, the muscles and fasciæ constituting the buttress had either torn away completely from Poupart's ligament, or had united in a flimsy manner. This result can manifestly be accounted for in one of two ways: either the suture material cut through or it became absorbed before firm union had taken place. I do not believe that the sutures cut through, because we should then find cicatricial tissue; as a matter of fact, we do not. It is obvious, therefore, that the muscles separated because of too early absorption of the catgut. The transplanted muscles always tend to pull away from Poupart's ligament: at best, there is but little tendency for firm union between muscle fibers and ligamentous tissue. Certainly, if these two facts hold good, there can be no firm union between the transplanted muscles and Poupart's ligament in the time that even heavy strands of chromicized catgut will last.

As a result of this observation, we have followed in the footsteps of Dr. Wiener, of Mt. Sinai Hospital (65), and have discarded chromicized catgut for all deep sutures in hernial plastics.

Some surgeons use silver wire for this purpose; but this material has the disadvantage that, no matter how the knot is fastened, the free ends cause irritation and frequently require removal after a prolonged sinus formation.

For the deep layer of sutures we prefer silk, or better Pagenstecher celluloid thread. The latter is perfectly sterilizable by boiling; even the finer numbers are of great strength; its knots are of very small size; it becomes perfectly encapsulated, and does not irritate the tissues.

I do not wish to convey the impression that linen thread is preferable because it is permanent. If permanency were the aim, we would not place reliance upon so frail a substance as a number 2 linen thread. The idea is that linen thread lasts sufficiently long for the establishment of a firm union between the internal oblique and transversalis muscles and conjoined tendon and Poupart's ligament.

Some surgeons favor kangaroo tendon for this work. This material holds an intermediate position between catgut and linen or silk. Being an animal substance, kangaroo tendon becomes absorbed after a sufficient time. There is no question that kangaroo tendon is eminently fitted for this work. It has only two disadvantages: first, the strands are exceedingly thick and uneven, and second, its high cost. These disadvantages are slight but are, nevertheless, disadvantages which linen thread has not.

For suturing the divided aponeurosis of the external oblique, the finer numbers of chromicized catgut are recommended. As a rule, there is very little tension on this suture line; moreover, the two edges, with or without overlapping, unite very readily.

For uniting the skin incision, silk, Michel clips, or any other material may be used.

OBLIQUE INGUINAL HERNIA

SURGICAL ANATOMY

The detailed anatomy of oblique inguinal hernia will not be discussed here. Those interested are referred to text books on descriptive anatomy. (More can be learned regarding the surgical anatomy of hernia in the dissecting room than in text books, or in the operating room.)

Briefly the following structures are encountered in an operation for oblique inguinal hernia.

1. The skin, subcutaneous fat, and superficial fascia.
2. The aponeurosis of the external oblique muscle, and its contingent structures, namely, the external inguinal ring and its two pillars, the intercolumnar fibers, and the intercolumnar fascia.
3. The internal oblique and transversalis muscles, and "conjoined tendon."
4. The cremaster muscle and cremasteric fascia.
5. The spermatic cord.
6. Poupart's ligament.
7. The deep epigastric vessels.
8. The transversalis fascia, internal inguinal ring, properitoneal fat, and peritoneum.

1. **Skin, Subcutaneous Fat, and Superficial Fascia.**—The skin, subcutaneous fat, and superficial fascia require no special description. It is worth mentioning, however, that, in dividing these structures, there is always encountered a rather good-sized vessel, the superficial epigastric, a branch of the femoral, running practically at right angles to the line of the incision; this vessel requires ligation.

2. **The Aponeurosis of the External Oblique Muscle and Its Contingent Structures.**—In an ordinary operation for inguinal hernia the muscular portion of the external oblique is never encountered. Its aponeurotic portion is, however, of considerable importance. (At this point the writer would plead for the retention of names which have been universally adopted. Some writers speak of the "fascia of the external oblique," which is entirely erroneous, as its anatomical name is "aponeurosis.") This aponeurosis is a membranous expansion of the external oblique; while not of great thickness, it is of great

strength; its fibers may sometimes spread out; rarely, congenital splits may be seen, but these do not materially decrease its strength. If such splits are found during the operation, they may be utilized with advantage, instead of making another incision.

At the lower and median portion of the incision there is seen a very distinct triangular separation in the aponeurosis, the external inguinal ring, which serves as the place of exit for the spermatic cord. It is bounded above and below by a thickening of the fibers of the external oblique, called the external and internal pillars. The external pillar is continuous with Poupart's ligament, and is attached to the spine of the pubis. The internal pillar is attached to the anterior surface of the body of the pubic bone. Just above and somewhat to the median side of the external inguinal ring, the aponeurosis of the external oblique is perforated by the hypogastric branch of the ilio-hypogastric nerve.

The pillars of the ring are reinforced and covered by transverse fibers. These fibers are curved with the convexity downward, and extend upward beyond the confines of the external inguinal ring. All are held together by a thin fascia, called the intercolumnar fascia. The testis in its normal descent, and, therefore, also, a hernia which passes beyond the confines of the external inguinal ring, derives one of its coverings from this fascia.

The external surface of Poupart's ligament should never be encountered in an operation for inguinal hernia. Its internal or superior surface, however, must be exposed to its full extent and is of importance. In order to expose this ligament properly, the aponeurosis of the external oblique must be incised, and the inferior or external flap well retracted. Even then the ligament cannot be seen, because it is still covered by the spermatic cord, the cremaster muscle, and its binding fascia. These structures will, therefore, be described first.

3. The Internal Oblique and Transversalis Muscles and Conjoined Tendon.—After incising the external oblique in the direction of its fibers and retracting the upper and lower flaps, there are exposed, for their lowermost 1 in., the arched fibers of the internal oblique muscle. These take their origin from the outer third of Poupart's ligament, and, arching over the spermatic cord in a downward and inward direction, are inserted into the outer edge of the sheath of the rectus muscle. The transversalis muscle is not seen, being hidden behind the fibers of the internal oblique muscle.

The internal oblique muscle is attached by a thin aponeurosis to the external margin of the sheath of the rectus muscle. Its most inferior fibers join those of the transversalis muscle, become tendinous, and, curving downward, attach to the crest of the os pubis and pectineal line. This portion has received the name of the "conjoined tendon." In the operation for inguinal hernia, a small space toward the mesial side of our operative field remains after the united internal oblique and transversalis muscles have been sutured to Poupart's ligament. To cover this defect, the rule is to utilize this conjoined tendon. Attention is called to this point, merely because many surgeons confuse the internal oblique and transversalis muscles with the conjoined tendon.

Upon the exposed surface of the internal oblique muscle, about ½ to ¾ in. from its inferior margin, there runs, parallel to its fibers, a fair-sized nerve—the ilio-inguinal.

4. **The Cremaster Muscle and Cremasteric Fascia.**—*Just beneath the inferior curved edge of the internal oblique muscle are seen muscular fibers of varying degrees of thickness and size, which, if followed, will be found to have* the same origin and insertion as the lowermost fibers of the internal oblique muscle. Between their origin and insertion, the muscular fibers form a series of curved loops; the upper are short; from these the loops become longer and longer as we descend, the lowermost reaching down to the testis and attaching to the tunica vaginalis. These muscular fibers are held together by a thin layer of fascia called the cremasteric fascia.

In its normal descent into the scrotum the testis and spermatic cord, and, therefore, also, an oblique inguinal hernia, derives one of its coverings from the cremaster muscle and cremasteric fascia.

In order to expose the spermatic cord, it is necessary to divide this fascia. Unless this is done, the cord cannot be lifted without undue traumatism.

5. **The Spermatic Cord.**—The integral parts of the spermatic cord are the spermatic artery, the spermatic veins, and vas deferens. The spermatic artery is a branch of the aorta. The right spermatic vein empties into the inferior vena cava, the left spermatic vein empties most frequently into the left renal vein. Just beyond the internal inguinal ring the structures composing the spermatic cord become separated; the vessels ascend upward, inward, and slightly backward; while the vas deferens descends downward, inward, and slightly backward, in order to reach the seminal vesicle. It is only at the internal inguinal ring, after these three structures have pierced the transversalis fascia (infundibuliform fascia), that we can speak of a spermatic cord. There is, as a rule, only one spermatic artery, but there may be numerous veins—usually two in the upper part. As we follow the cord downward, the veins become more numerous and communicate with one another. Indeed, the greatest bulk of the cord is made up of a mass of veins, known as the pampiniform plexus.

It is important to remember, particularly in connection with various operations for undescended testis, that a very fine vessel, most frequently derived from the middle or inferior vesical artery, always accompanies the vas deferens.

The fascial and muscular structures of the cord do not derive their blood supply from the spermatic artery or the artery of the vas deferens, but from the deep epigastric artery and other vessels.

There exists also within the spermatic cord a cord of tissue, the remains of the obliterated processus vaginalis; excepting in congenital herniæ, this structure is of no consequence and may be disregarded.

The nerves of the spermatic cord are derivatives of the sympathetic nervous system and genital branch of the genitocrural nerve. The lymphatics carry lymph from the testis to the iliac and lumbar glands. Having now divided every structure that is in the way, the cord can be readily lifted away from its bed. This exposes Poupart's ligament.

6. Poupart's Ligament.- Poupart's ligament is connected with the lower flap of the divided aponeurosis of the external oblique muscles. It extends from the anterior superior spine of the ilium to the spine of the pubis. The external and, at the same time, inferior surface (not seen in an operation for inguinal hernia) is continuous with the fascia lata of the thigh. Its upper surface is shining and white. The outer third, or sometimes even the outer half, gives origin to the lower fibers of the internal oblique and transversalis muscles. In cross-section, the ligament describes an almost semicircular groove; this groove becomes more and more shallow toward its median end, and serves as a resting place for the cord.

Retracting the two leaves of the divided aponeurosis of the external oblique muscle and, also, pulling the cord out of the way, expose an irregular triangular space, bounded below by the shelving edge of Poupart's ligament, above by the internal oblique muscle, and internally by the conjoined tendon and edge of the rectus muscle. The floor of this triangle is made up of the transversalis fascia, which is rather strong in this location, unless there coexists a direct inguinal hernia. Somewhat nearer to the outer than to the inner half, this triangular space is divided into two parts by a fairly large vessel accompanied by two venæ comites, the deep epigastric artery, a branch of the external iliac artery.

7. The Deep Epigastric Artery. This vessel is an important landmark, because it determines whether an inguinal hernia is direct or indirect. A hernia which escapes on the outer side of the deep epigastric vessels is oblique; one escaping on the inner side is direct.

8. The Transversalis Fascia, Internal Inguinal Ring, Properitoneal Fat, and Peritoneum.- If there is no hernia, the peritoneum smoothly covers the upper surface of the internal inguinal ring; if a hernia is present, there is a bulging of the peritoneum into and through the internal inguinal ring. The peritoneum involved is that lining the iliac fossa and anterior abdominal wall, because the internal inguinal ring is located just at the angle of reflection, where the transversalis fascia becomes pelvic fascia.

If this part of the peritoneum is examined from within the abdomen, it is found loosely attached to the subserosa. Underneath the peritoneum, covering the anterior abdominal wall, there are seen slight but, nevertheless, distinct elevations, separated by shallow depressions. The elevation in the median line is caused by the urachus; between it and the next elevation, which is caused by the obliterated hypogastric artery, lies the first shallow depression, the internal inguinal fossa. On the outer side of the obliterated hypogastric artery, between it and the elevation caused by the deep epigastric vessels, there is the second depression, the middle inguinal fossa; and finally on the outer side of the deep epigastric vessels, there is the external inguinal fossa. An oblique inguinal hernia always passes through the external inguinal fossa. A direct inguinal hernia may pass through the middle or through the internal inguinal fossa (Fig. 5).

It is customary to distinguish a body, a neck, and a fundus of the sac. Shortly after the development of a hernia, the hernial sac is a very simple affair, and can best be compared to a smooth glovefinger-like protrusion, made up of the delicate peritoneum. After the hernia has existed a long time, the peritoneum not infrequently becomes thickened and may undergo changes as the result of traumatism or inflammation. Adhesions may form between apposed surfaces of the sac or between the sac and hernial contents; diverticula may form. The sac may become constricted at certain points, giving it an hourglass appearance; if there are many such constrictions, the sac resembles a rosary.

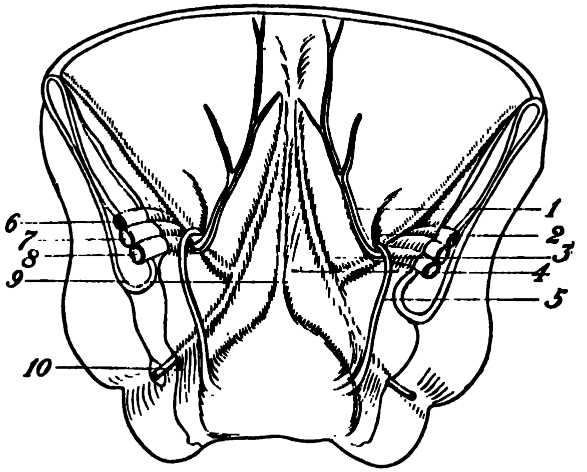

FIG. 5.—POSTERIOR VIEW OF ANTERIOR ABDOMINAL WALL IN ITS LOWER HALF; SHOWING THE VARIOUS CORDS AND INGUINAL FOSSÆ. 1, Deep epigastric artery; 2, external inguinal fossa; 3, middle inguinal fossa; 4, internal inguinal fossa; 5, vas deferens; 6, anterior crural nerve; 7, external iliac artery; 8, external iliac vein; 9, urachus; 10, obliterated hypogastric artery.

An individual may have a hernia both through the external inguinal fossa and through the middle or internal inguinal fossa; such a patient, therefore, has both an oblique and a direct inguinal hernia, separated by the deep epigastric vessels; such double sacs have been designated "pantaloon" herniæ. In the course of an operation it is important to examine for such extra sacs or herniæ; if one sac is overlooked, a recurrence will usually take place.

In rare cases there is no distinct sac, only a diffuse bulging of the entire triangular area situated between Poupart's ligament and the internal oblique muscle divided by the deep epigastric artery. These cases are difficult to treat. In a few cases of this nature, I divided the deep epigastric artery, and, after putting this bulging on the stretch, reefed the underlying transversalis fascia and peritoneum.

The structures situated behind Poupart's ligament—for instance, the external iliac artery and vein—are not exposed in an operation for inguinal hernia, but it is important to remember their close proximity in order to avoid injuring them.

It is superfluous to add that every oblique hernia derives as its final covering the infundibuliform fascia and peritoneum.

It is to be noted that I have omitted all mention of properitoneal fat. In a normal oblique inguinal hernia no properitoneal fat is pushed ahead of the peritoneum, for the reason that no properitoneal fat exists in this region.

The channel through which the spermatic cord and oblique inguinal hernia passes forms the so-called inguinal canal; its proximal opening is the hiatus in the transversalis fascia—the internal inguinal ring; its distal opening is the external inguinal ring. The floor is made up of the transversalis fascia, upon which the deep epigastric vessels run upward and inward. The inferior boundary is Poupart's ligament. Finally, it is covered by the transversalis and internal oblique muscles at its external extremity and for the rest of its extent by the aponeurosis of the external oblique muscle only.

OPERATIONS FOR OBLIQUE INGUINAL HERNIA

The radical cure of hernia, although long recognized by physicians and even by laymen, is a comparatively recent invention. Attempts to cure oblique inguinal hernia were, of course, made long before the present era. The results were poor, as far as a cure is concerned, and the outcome not infrequently fatal. The modern treatment of hernia dates from the first report of Bassini (5) in 1891. For practical purposes all operations previous to this date can be ignored.

Bassini's operation even now is performed frequently in its original, unaltered form; moreover, it is the fundamental operation upon which all modifications are based; it therefore deserves detailed description.

BASSINI'S OPERATION

1. Incision of the skin, superficial fascia, and subcutaneous fat, extending from beyond the internal inguinal ring, downward and inward, to the spine of the pubis; the incision runs almost parallel with the fibers of the aponeurosis of the external oblique muscle. The length of the incision depends upon the adiposity of the individual, but it is approximately 3 in. long.
2. Incision of the aponeurosis of the external oblique muscle in the direction of its fibers, beginning at the external ring and extending to a point well beyond the internal inguinal ring. Retraction of both the upper and lower flaps exposes the united internal oblique and transversalis muscles, the conjoined tendon, the edge of the rectus muscle, and the spermatic cord, with the hernial sac resting upon the transversalis fascia and shelving edge of Poupart's ligament.
3. The next step is the complete isolation of the sac up to the internal inguinal ring. The sac is then opened, its contents inspected and dealt with according to indications. Bassini then twisted the neck of the sac and placed a

ligature around it; if the neck of the sac was very large, he first transfixed it, in order to prevent the ligature from slipping.

4. The cord is then lifted upward and inward out of the way; occasionally the testis is brought entirely out of the scrotum to facilitate the next step, which consists in the passing of interrupted silk sutures, uniting the internal *oblique and transversalis muscles and conjoined tendon to Poupart's ligament. Upon this newly formed pad the spermatic cord is replaced.*

5. Suturing of the divided aponeurosis of the external oblique muscle; over which

6. The skin is sutured.

If this operation is analyzed, it will be seen that Bassini did not, as he asserts, reconstruct the old canal, but actually constructed a new one; for in the normal human being the cord never rests upon the internal oblique muscle, but is covered by it. The original Bassini operation is excellent, because it embodies the two essentials previously discussed; namely, the high ligation of the sac and the placing of a firm barrier at that area of the abdominal wall weakened by the passage of the hernia.

Of all operations done for the cure of inguinal hernia, Bassini's is the one practiced with the greatest frequency. The results obtained are excellent. The modifications of this operation are legion. Indeed, they are so numerous that they are constantly being rediscovered. It will be impossible, within reasonable limits, to describe every modification. Only the more important modifications will therefore be considered.

Coley's Modification of Bassini's Operation

In the original Bassini operation the cord emerges from underneath the internal oblique muscle. To many observers it appeared that the point of the exit of the cord remained a *locus minoris resistentiæ*. Coley reënforced this apparently weak point by placing one or two sutures above the point of emergence of the cord. In the original Bassini operation the cord emerges at the upper end of the deep suture line; while in the Coley modification the cord emerges in the suture line. This modification is a rational one and has been generally adopted.

Halsted's Modification

Halsted and his confrère Bloodgood have supplied us with numerous modifications of the Bassini operation.

1. Prior to the introduction of the deep stitches, the internal oblique and transversalis muscles are incised at the upper angle, transversely to the direction of the fibers, for a distance of about 1 to 2 in. The cord is placed into the upper angle of this incision: and this incision is sutured; the muscles are then sutured to Poupart's ligament.

2. Excision of most of the veins of the spermatic cord in order to diminish its caliber.
3. In a subsequent modification the transplantation of the cord was discontinued; and an additional muscular layer was made by suturing the cremaster muscle underneath the internal oblique and transversalis muscles.
4. The use of silver wire as suture material.
5. When the conjoined tendon is deficient, the anterior sheath of the rectus muscle is incised, reflected downward, and sutured to Poupart's ligament.

Wölfler's Modification

After suturing as much of the internal oblique and transversalis muscles to Poupart's ligament as possible, there still appears at the lower angle of the suture line a weak uncovered area. In order to fortify this part, Wölfler recommended incising the anterior sheath of the rectus muscle; this muscle is mobilized, drawn outward and downward, and sutured to Poupart's ligament.

Such an operation when finished appears theoretically perfect. I am afraid, however, that most of its advantages are illusory. Through the constant pulling of the very strong rectus muscle, one of 2 accidents usually happens: the sutures, if not absorbable, cut through, or, if of catgut, become absorbed, and before long the rectus returns to its original position.

In order to prevent such an occurrence, this modification has been modified further by subsequent operators. Some incise the edge of the rectus sheath, some the posterior sheath only, and some make flaps from the anterior sheath, the flaps alone being transplanted. The advantage to be derived from any one of these modifications is not great.

Wölfler also modified the Bassini operation by transplanting the cord, so that it escaped into the scrotum between the fibers of the rectus muscle just above the symphysis.

Ferguson-Coley Modification

This is the most important modification of the Bassini operation. This operation differs from Bassini's in that the spermatic cord is not transplanted.

Up to the point of inserting the sutures the two operations are identical, so that there is no necessity of reviewing the various steps.

After the sac has been ligated and cut away, the sutures are inserted in the following manner. Leaving the spermatic cord undisturbed, interrupted sutures are passed, uniting the internal oblique and transversalis muscles and conjoined tendon to Poupart's ligament. By tying these sutures, the cord is buried. The difference between the two operations, therefore, is that in the Bassini operation the sutured muscles lie behind the cord, while in the Ferguson-Coley operation they are in front of the cord.

The weakness in the abdominal wall, i. e. the exit of the spermatic cord, is, therefore, transferred from the upper to the lower angle of the suture line.

The subsequent steps are identical in both operations.

The discussion of the advantages of one operation over the other will, for special reasons, be deferred until after the description of the surgical anatomy and cure of direct inguinal hernia.

ANDREWS' OPERATION

This operation (1, 2) is the most important modification of the Bassini operation that has been devised thus far, and in my opinion is the operation of choice for oblique inguinal hernia.

I have already called attention (page 6) to the paramount importance of fasciæ in the retention of the abdominal contents within the peritoneal cavity, and the subsidiary rôle exercised by the muscles. Andrews' operation differs from all others in that the buttress overlying the weak part of the abdominal wall is made up not merely of muscle, but also of one of the strongest soft structures in the human frame, the aponeurosis of the external oblique muscle. As this operation is the one that I recommend, it will be described in detail.

1. **Skin Incision.**—The incision should be 3 to 4 in. in length, depending upon the amount of subcutaneous adipose tissue. Shortness of incision should not be striven for; the main desideratum is perfect exposure, in order that each step can be executed under the guidance of the eye, and not by touch merely. The incision is not quite parallel with Poupart's ligament, but is slightly more vertical, the aim being to make it parallel with the fibers of the aponeurosis of the external oblique muscle. The incision begins at the external inguinal ring, and extends upward and outward for the distance stated. The cutaneous incision should not extend too low, because it is very difficult to apply a proper dressing to these parts, which increases the consequent risk of infection. Furthermore, we come into conflict with the venous plexus of the mons veneris, requiring a multitude of ligatures for the control of hemorrhage. A few cutaneous vessels are clamped and the superficial epigastric vessels always, as they run practically at right angles to the incision.

Retraction of the skin and subcutaneous fat exposes the aponeurosis of the external oblique muscle.

2. **Incision of the Aponeurosis.**—The aponeurosis is now incised, in the direction of its fibers, through the external inguinal ring (Fig. 6). Occasionally there is found a slit in the aponeurosis, which, of course, may be utilized for this incision. The intercolumnar fibers and fascia are divided.

The hypogastric branch of the iliohypogastric nerve is seen to perforate the upper leaf of the aponeurosis and can, as a rule, be saved with a little care.

Not much retraction of the upper flap of the aponeurosis is necessary for the subsequent steps; indeed, pains are taken to handle it as little as possible. Particular attention should also be paid not to dissect it away from the underlying internal oblique muscle.

The lower flap is sharply retracted and the cord structures lifted away. By wiping with gauze, we now expose clearly as much of Poupart's ligament as proves necessary; it is particularly important to carry this exposure of Poupart's ligament up to its attachment to the spine of the pubis.

3. **Extirpation of the Sac.**—The cremaster muscle and cremasteric fascia are now incised, the cord is grasped and search made for the hernial sac. In doing this it is important to remember that in oblique inguinal hernia the sac is always to the inner side of the cord; by much traumatism and twisting the sac can be reached even from the outer side of the cord, but this is a faulty procedure. In an old hernia the sac is usually considerably thickened, and can be readily recognized by its paler color; in a hernia of recent standing the sac is sometimes so thin and translucent as to escape detection. I prefer to begin the isolation of the sac at some distance from the internal inguinal ring; some advise beginning the dissection at the internal inguinal ring. The finding of the sac is perhaps easier, if the latter plan is followed, but its isolation is certainly more difficult.

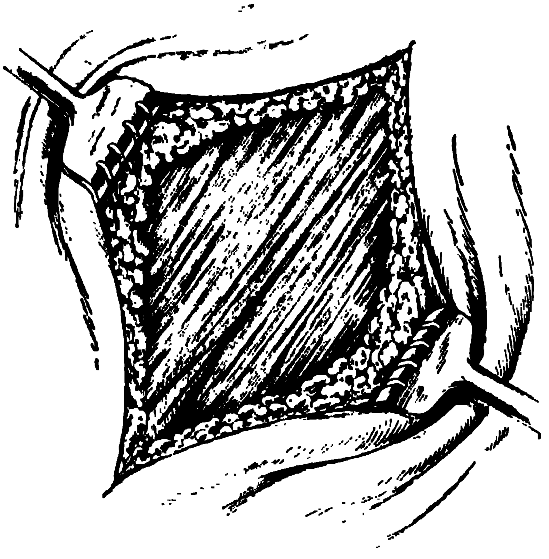

FIG. 6. ANDREWS' OPERATION FOR INGUINAL HERNIA; SHOWING INCISION IN THE APONEUROSIS OF THE EXTERNAL OBLIQUE.

A further important point to remember is that both the hernial sac and the cord are covered by the infundibuliform fascia; it is necessary, therefore, to first split this structure. If this is done, the peritoneum is easily liberated without sharp dissection.

I prefer to reduce the contents of the sac, if reducible, before isolating it. If there are adhesions between the hernial contents and the sac, they are dealt with according to indications. Care must, of course, be taken not to injure the intestine. If the adhesions are firm and vascular, it is wise to ligate them between two ligatures.

HANDLING OF THE OMENTUM.—The question of how to deal with large masses of omentum prolapsed into a hernia is a very important one. Some surgeons favor the removal of all prolapsed omentum, particularly if large in amount. They base their arguments on 2 reasons: (1) that the omentum is an unnecessary organ; (2) that when the omentum is removed, there is less chance of recurrence. I am opposed to these views. That the omentum has important functions has been *repeatedly shown by many investigators. Furthermore, it is illogical to assume that, because the omentum is removed, the hernia is thereby less likely to recur. Finally* the extirpation of large *pieces of omentum is not entirely* devoid of risks. These risks may be enumerated as follows. 1. Ligatures have been known to slip, with resultant, sometimes fatal, secondary hemorrhages. 2. A retrograde thrombosis occasionally occurs, which extends to other branches of the portal vein, particularly the vessels that drain the transverse colon and stomach; such a retrograde thrombosis may be the source of very annoying, if not fatal, gastric or intestinal hemorrhages. These accidents have been especially described in German reports. 3. It occasionally happens that a chronic inflammation begins around the ligatures, resulting in the deposition of massive exudates; these exudates give rise to veritable tumors, causing much pain and tenderness. These tumors are very difficult to cure, and in a great many instances, after long and tedious attempts at relief with local applications, such patients finally come to laparotomy. In most instances the center of these masses is the seat of a small chronic abscess.

Excluding strangulation, there is only one indication for the resection of omentum; and that is when the omentum is irreducible. This is apt to occur in cases of hernia of long standing, when the prolapsed omentum has become so traumatized that large, dense, ball-like masses are formed, which offer a mechanical bar to reduction. In a few very rare instances, the size of the prolapsed omentum prevents its complete reduction.

METHOD OF REMOVAL OF OMENTUM.—The following are points to be emphasized. 1. The ligature should consist of nothing but catgut. 2. The individual pedicles are not to be made thicker than the size of the little finger. 3. The ligatures should be so placed and tied that there is no possibility of their slipping off.

After the hernial contents have been replaced, it is wise to sweep the finger around the neck of the sac within the peritoneal cavity to determine if there are any adhesions in the neighborhood. If such adhesions are present, they, too, should be liberated. If the neck of the hernial sac is small, traction upon the sac is sufficient to prevent further prolapse of the intestine during the subsequent manipulations; if the neck is wide, a narrow packing, judiciously placed, will assist in holding back the abdominal contents.

The edge of the incision in the sac is now grasped by a few artery forceps —traction is made, and all the tissues external to the sac are carefully dissected away. A finger introduced into the sac greatly facilitates this manipulation. If the peritoneum alone has been grasped, the liberation of the sac proceeds very smoothly; indeed, it can be done bluntly, by wiping away the tissues with a piece of gauze, assisted only occasionally by a snip with the scissors.

AVOIDANCE OF INJURY TO THE SPERMATIC CORD.—During the preceding manipulations care must be taken not to injure the vas deferens. This structure can always be felt and seen, and if its close proximity is constantly borne in mind, care will prevent its injury. Injuries to the vas deferens are always avoidable, and are always due to carelessness. If the vas deferens is injured, it should always be repaired; the method will be discussed later.

All unnecessary traumatism to the vessels of the spermatic cord should also be avoided; major injuries, such as tearing or division of the spermatic artery, may be followed by necrosis of the testis; rough handling or injury of the spermatic veins or pampiniform plexus may be followed by thrombosis of these vessels, leading to an orchitis, which prolongs convalescence.

At this step of the operation even the slightest bleeding points should be caught and ligated with fine catgut. In the loose cellular tissues in which the work is performed, bleeding from even the smallest vessels is very likely to be followed by an extensive hematoma, which may prevent primary union, and, therefore, lead to a recurrence.

The isolation of the sac should be extended well up beyond the deep epigastric artery; indeed, up to the point where the neck of the sac becomes continuous with the general peritoneal cavity. This part of the isolation of the sac must be done with the greatest gentleness, because here the peritoneum is very thin and, therefore, easily torn. This is an accident of no great consequence, but it renders the application of a suture or ligature to the neck of the sac needlessly difficult.

AVOIDANCE OF INJURY TO THE BLADDER. In isolating the sac at its upper part, and more particularly upon the mesial side, there is encountered very frequently a mass of fatty tissue. Here another word of caution is necessary, because the bladder lies just beneath this fatty mass; and unless care is exercised, injury to the bladder may very readily occur. At the same time the presence of this fat should not lead us to the belief that the neck of the sac has been reached. The isolation of the neck of the sac must be carried still further.

My method of procedure is the following: With blunt dissection the bladder can be dissected free from the peritoneum; the dissection is carried out until the obliterated hypogastric artery is encountered (this can be recognized both by sight and touch, resembling in size and feel the vas deferens); the bladder is now pushed back, and the ligation of the sac proceeded with.

LIGATION OF THE SAC.—If the neck of the sac is narrow, the entire sac is lifted with slight traction; a needle armed with No. 2 iodin catgut is passed through the neck of the sac at about its middle, and tied first on one side, then on the other, and finally en masse in the same groove. If the neck *of the sac is wide, it is better to close it by a purse-string suture passed from within the sac (Fig. 7).* The redundant portion of the sac is now cut away, about ½ cm. distal to the ligature. *If this step of the operation is properly done,* the stump slips back spontaneously. When the operation is carried out properly, a view from within the peritoneal cavity shows, at most, a slight puckering of the peritoneum at the site of the internal inguinal ring. Under no circumstances must a dimple or a small saccule be left behind; these might be the starting point of a recurrence.

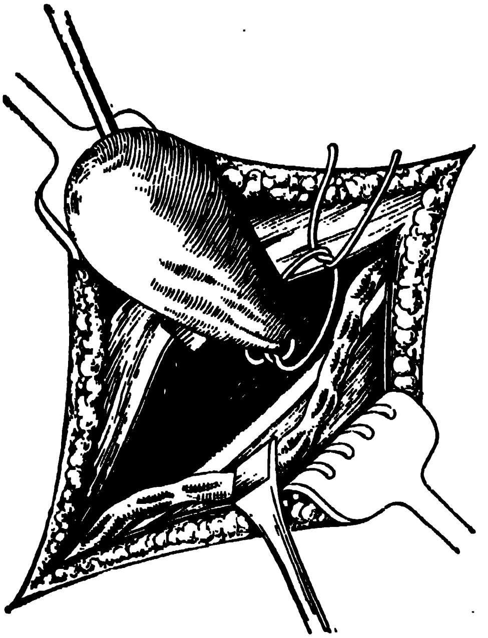

Fig. 7.—Andrews' Operation for Inguinal Hernia; Showing Transfixion and Ligation of the Neck of the Sac.

The cord is now replaced in its bed, care being taken that all hemorrhage, even the slightest, has been controlled. We now proceed to the next step.

4. **Formation of the Buttress.**—The wound is exposed in the following manner: The upper retractor is placed into the skin and subcutaneous fat, thereby exposing the cut edge and anterior surface of the aponeurosis of the external oblique muscle. The lower retractor is placed one layer deeper, exposing to full view the shelving edge of Poupart's ligament. Small, full-curved needles armed with No. 2 Pagenstecher's celluloid thread are now passed in the following manner: On the upper side, each suture grasps the aponeurosis of the external oblique and the united internal oblique and transversalis muscles; when the limit of these muscles has been reached, the next sutures grasp the aponeurosis of the external oblique muscle and conjoined tendon; further toward the median line the upper sutures grasp the aponeurosis of the external oblique muscle and the edge of the sheath of the rectus muscle. Upon the lower side, all the sutures should be so inserted as to take a firm bite of the shelving edge of Poupart's ligament (Fig. 8).

In passing these sutures through the upper side, the following point should be noted. The ilio-inguinal nerve, which runs on the anterior surface of the internal oblique muscle, should be avoided, and not be either pierced, or tied within the sutures. If the nerve runs too near the edge of the internal oblique, it should be lifted out of

the way. Many cases of pain and neuralgia, after operations for hernia, are due to the careless inclusion of this nerve within the sutures.

In passing the sutures through the shelving edge of Poupart's ligament the following points should be noted: 1. The sutures are to be passed by sight; it is important, therefore, that the tissues be well retracted, so that Poupart's ligament can be perfectly seen. 2. The sutures are to be passed in different lines of cleavage in Poupart's ligament; otherwise Poupart's ligament may fray or split when the sutures are tied. 3. The needle must not be passed too deeply; neglect of this point has resulted in injury to the deep epigastric and external iliac vessels.

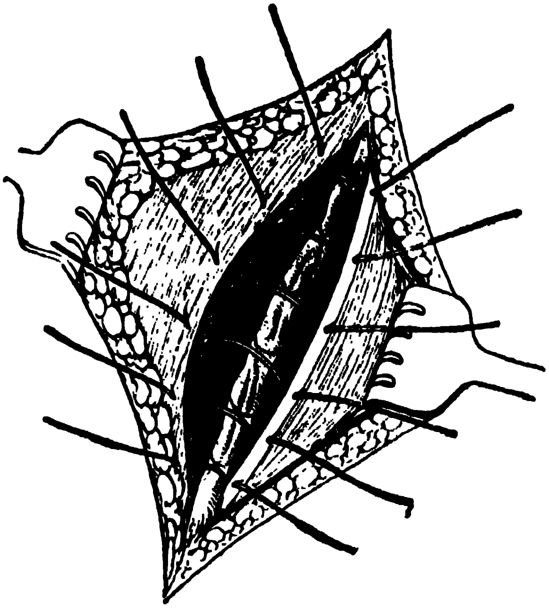

FIG. 8.—ANDREWS' OPERATION FOR INGUINAL HERNIA WITHOUT TRANSPLANTATION OF THE SPERMATIC CORD. Upper stitches grasp the aponeurosis of the external oblique, the internal oblique and transversalis muscles and conjoined tendon.

No definite rule can be formulated as to the number of sutures necessary. Sufficient are to be passed so that, when tied, the entire inguinal canal is closed, leaving at the lower angle enough room for the escape of the cord without strangulating it. The lowermost suture is inserted upon the spine of the pubis. The sutures are tied snugly, but not so tightly as to strangle the tissues. If the sutures are too tight, the muscles within their grasp degenerate and are eventually converted into cicatricial tissue. In the tying of the sutures the assistant depresses the muscles, facilitating the approximation of the aponeurosis to Poupart's ligament. When all the sutures are properly tied, no muscle whatever is seen in the field of the operation.

Sutures of Pagenstecher linen, when tied, have no tendency to become unknotted; the ends may, therefore, be cut fairly close to the knot.

5. Overlapping of the Aponeurosis of the External Oblique.—The skin and subcutaneous fat on the upper half of the incision are now retracted, and, if necessary, are even dissected further away, in order to expose a good part of the surface of the aponeurosis of the external oblique muscle.

Sutures of No. 2 chromicized catgut are now passed in the following manner: Each suture grasps, on the one side, the anterior surface of the upper part of the aponeurosis of the external oblique, and, on the other side, the cut edge of the lower flap of the aponeurosis. When these are tied, the lower flap overlaps the upper throughout its entire extent (Fig. 9).

6. **Closure of the Skin.**—In thin individuals the skin incision is closed by Michel's clips; in fat individuals a silk suture first approximates the skin and subcutaneous fat.

7. **Dressing of the Wound.**—The dressing of the wound requires considerable care and judgment. Some surgeons use very little dressing, being content with a few small strips of gauze fastened on with collodion; others use very voluminous dressings, which include the scrotum and testes, extending downward *upon the thighs* and upward to the ribs. While the first is not safe, the latter is exceedingly irksome to the patient, especially in warm weather.

Our dressing is a compromise between the two. A compress of gauze is placed over the wound; over this are placed a few pieces of loose gauze; these are again covered by a flat compress. A snugly fitting spica bandage is then applied, leaving the penis, scrotum, and anus free. The loose gauze between the two compresses is necessary, in order that firm compression may prevent all capillary oozing. Its omission is frequently attended by the formation of a hematoma, or at least by the escape of aseptic serum.

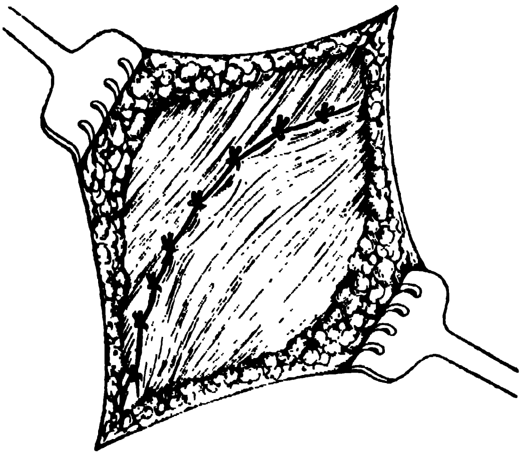

FIG 9.—ANDREWS' OPERATION FOR INGUINAL HERNIA. Overlapping of the aponeurosis of the external oblique.

Operation for Oblique Inguinal Hernia in the Female.—The radical operation of oblique inguinal hernia in the female is the same as in the male. In the female the round ligament is treated in the same manner as the spermatic cord.

I have described this particular operation at some length, because to my mind it is infinitely superior to all others. It would be needless, therefore, to speak of other modifications. There is, however, one more operation for oblique inguinal hernia which, in the hands of its originator, has given excellent results, although its underlying principle is entirely different from that of Bassini. A short description of it appears, therefore, to be indicated. I refer to the "Verlagerung's Methode" of Kocher.

KOCHER'S OPERATION

Kocher's operation has, even in the hands of its originator, undergone numerous modifications; and in the latest reports from his clinic (33) there are described 2 modifications, each of which has its own indications. The method cannot be used in strangulated or even in irreducible hernia.

1. A cutaneous incision, extending upward from the external inguinal ring, parallel with the fibers of the aponeurosis of the external oblique, exposes the external inguinal ring and anterior surface of the aponeurosis.

2. The sac is isolated from the spermatic cord at the external inguinal ring, freed as far as its distal extremity, and lifted out of the wound. All this, it must be understood, is done without splitting the aponeurosis of the external oblique.

3. The next step is done in 2 different ways.

(a) "Invaginations Verlagerung" is used when the sac is complete and has not been incised or torn in the previous manipulations. Curved dressing forceps grasp the apex of the sac, and the sac is then invaginated around the forceps; the forceps now enters the external inguinal ring and is passed underneath the aponeurosis of the external oblique until it is opposite the internal inguinal ring or even slightly beyond it. Using the dressing forceps as a guide, a small incision is now made in the aponeurosis of the external oblique and deepened until the cut extends through the external layer of the sac. The invaginated sac is grasped by an artery forceps and pulled out. The sac is then pulled taut, transfixed, ligated, and cut away; the stump slips back; the parietal peritoneum and aponeurosis of the external oblique are then closed by sutures.

(b) "Laterale Verlagerungs Methode" is used if the invagination method is impossible because of the shortness, tension, or thinness of the sac, or when it has required incision. In this case the tip of the sac is caught in the curved dressing forceps, and is then passed through the external inguinal ring (without invaginating the sac), underneath the aponeurosis of the external oblique, up to a point opposite the internal inguinal ring, or even a little beyond it. At this point a small incision is made into the aponeurosis, and through it the sac is pulled out: not being invaginated, no incision in the parietal peritoneum is necessary. The sac is pulled taut, transfixed, ligated, and the distal portion cut away. The stump slips back, and the small incision in the aponeurosis is sewed up.

4. The next step consists in a reefing suture of the aponeurosis of the external oblique and narrowing of the external inguinal ring to a size just permitting the escape of the cord.

5. Finally, the cutaneous incision is closed in the usual manner.

Careful analysis of what is done in either of the Kocher operations will show that the essential step is merely a high ligation of the sac.

If a radical cure results, it does not follow that the operation is good; at best it can be agreed that even simple high ligation of the sac may occasionally be followed by a radical cure. Why, then, is it necessary to advise such an elaborate method to accomplish this end?

According to the first reports, the Kocher operation gave results even better than the Bassini operation; but, even in the hands of the originator of the method, the reports are becoming less and less brilliant. In order to become acquainted with the method I did the operation in former years in a number of unselected cases, and the results were not satisfactory.

POSTOPERATIVE COURSE AND COMPLICATIONS

Unless there is a definite indication, e. g. a rise of temperature which cannot be accounted for otherwise, the dressings are not disturbed for 6 or 7 days. The cutaneous stitches or Michel clips are then removed. A lighter spica dressing is applied, and changed as often as necessary. It is customary to keep the patients in bed for 14 days. If their strength permits it, they leave the hospital on the sixteenth or seventeenth day. The spica bandage is discarded after another week.

1. **Retention of Urine.**—The most frequent complication is retention of urine. We postpone catheterization as long as possible, but most male patients require catheterization for one or two days. Because of the frequency with which catheterization is necessary, operation is contra-indicated in all cases of acute gonorrhea and strictures of the urethra.

2. **Tympanites.**—Postoperative distention of the intestines is a frequent complication, and is very annoying to most patients. Repeated enemata, occasionally with oxgall and peppermint, relieve this condition as a rule. On the third day the patient receives a cathartic, and thereafter there should be no disturbances on the part of the intestinal tract.

3. **Postoperative Fever.**—This is very frequently seen on the second or third day, and may reach as high as 101.5° F., or even 102° F. As a rule this fever becomes normal in a day or two. During the summer months children may get true hyperpyrexia, up to 106° F.; usually even this high temperature drops to the normal within 24 hours.

4. **Postoperative Pneumonia or Bronchitis.**—This is a common complication, especially in older people. Whether it is due to the anesthetic or to an embolic process has not been definitely decided. One thing is certain: pneumonia occurs just as frequently after operations under local as after general anesthesia. As a rule these pneumonias are of a mild type, and recovery is the rule, except in the very old.

5. **Infection of the Wound.**—Infection is very rare with modern technic and is usually slight, being limited to the skin. Opening of the infected wound is followed by prompt cure.

Serious infection occasionally occurs. Because of the extensive cellular planes that are opened up, such infections progress rapidly, and before one is aware of it extensive destruction may have taken place.

Cases of this nature must be treated energetically. No time should be wasted in attempts to preserve the chances for a radical cure. The tissues should be opened widely in order to combat the infection; indeed, the whole problem resolves itself into the treatment of a phlegmon. Not infrequently a portion of the fascial structures sloughs away. In the treatment of these phlegmonous infections, it is just as important not to do too much, as it is not to do too little. It is possible that the infection may be limited only to the more superficial planes. In these instances a radical cure is not excluded.

The peritoneal suture or ligature usually holds firmly, and is a firm barrier against infection of the peritoneum; peritonitis is, therefore, a rare complication.

6. **Intestinal Obstruction.**— Intestinal obstruction, due to causes entirely independent of the operation for the radical cure, may occur, but is certainly rare. In one case I observed a typical gastromesenteric ileus.

ACCIDENTAL DANGERS AND DIFFICULTIES ENCOUNTERED DURING THE OPERATION

1. **Injury of the Spermatic Artery.** The spermatic artery may be divided. Inasmuch as a suture of the vessel is practically impossible, it must be ligated. There is danger of complete necrosis of the normal testis; one may hope at least for a partial restoration of the circulation through the artery of the vas deferens; at best, the probability is strong that the testis will subsequently atrophy.

2. **Injury to the Spermatic Cord.** - Traumatism of the spermatic cord, particularly of the veins, is very frequently followed by thrombosis. If many of the veins are involved, the thrombosis may extend into the radicles within the testis and cause an infarct of this organ. This is readily recognized by a painful and tender swelling in the scrotum. Often atrophy of the organ follows. The disappearance of these symptoms can be materially hastened by elevating the scrotum and applying heat.

3. **Incomplete Hemostasis.** -This is followed by an extensive hematoma. Occasionally tumors of massive size form, which infiltrate the entire operative field and extend into the scrotum and down the thighs. The majority of these hematomata absorb; rarely the wound requires reopening or incision of the scrotum for drainage may be necessary.

4. **Division of the Vas Deferens.**—By never dividing or cutting any structure without first assuring oneself that the cut does not involve the vas deferens, accidents to this structure will not happen. The divided vas must be repaired, preferably by Fenger's method. After trimming both severed ends cleanly, they are threaded upon a very fine cambric needle; this is rather difficult, but practicable with a little patience. The two cut surfaces are then sutured together with very fine silk. Finally the sharp point of the needle is forced through the walls of the vas deferens and extracted.

5. **Injury to the Bladder.**—I have already called attention to the fact that, during the isolation of the neck of the sac, a mass of fat is frequently encountered. This mass of fat must be treated with caution, because its presence is a sign warning of the proximity of the bladder. This fat is a continuation of the adipose tissue filling the space of Retzius. When a true hernia of the bladder is present, this fat may form a large mass; when no hernia of the bladder is present, the mass of fat is small, and is in reality an artefact, being dragged out as the sac is pulled upon. Unless carefully isolated, as described before, 2 accidents may happen. A part of the bladder may be included in the ligature, or this viscus may be incised or torn. If recognized, the ligature must be removed; if ligation of the bladder is not recognized, sloughing of the bladder, with the formation of a urinary fistula, results.

An incision into the bladder or a tear must be immediately repaired by exact suture. None of these sutures must penetrate the lumen of the bladder; chromicized catgut may be used for the first row; silk or Pagenstecher's linen for the second or even third row. On no account must the suture line be drained or protected by gauze packing, for the reason that a fistula is apt to result. If one is not certain of the integrity of the suture line, a smooth drainage tube or rubber dam may be inserted for drainage. Some surgeons prefer to keep the bladder empty for a few days by introducing a permanent catheter, but this procedure is apt to cause a urethritis or cystitis. I prefer to catheterize such patients very frequently, say every 4 hours.

6. **Injury to the Intestine.**—In isolating and incising the sac the intestine may be injured. Immediate repair is, of course, necessary. Such injury is not as rare as is generally believed. Such injuries are especially liable to happen in cases of so-called "sliding hernia"; these herniæ frequently have no sac at all, or only a very minute one, and the gut is incised under the impression that it is the sac.

7. **Ligation of the Intestine within the Ligature of the Sac.**—If the sac is carelessly tied off, the ligature may include a small knuckle of intestine or a bit of omentum. To avoid this accident, it is best to have the assistant tie the ligature or suture entirely under the guidance of the eye, while the operator controls the neck of the sac. Should this accident happen, immediate liberation of the ligature is indicated. The subsequent procedure depends upon the amount of damage done.

8. **Slipping of the Ligature.**—A carelessly applied ligature may slip off during postoperative straining or vomiting; this may be followed by prolapse of the intestine.

9. **Injury to the Deep Epigastric Vessels.**—If injured, these vessels may be tied without fear of risk. Erdman (14) has published an interesting case in which the superficial epigastric artery was injured at its origin from the femoral artery, an accident which taxed the ingenuity of the surgeon to the utmost.

10. **Injury to the External Iliac Vessels.**—The external iliac artery or

vein may be injured if the deep sutures are carelessly passed. In order to avoid this accident, it is necessary to have good exposure, so that the needle is passed under perfect control. This accident, while fortunately rare, is more apt to happen when the operator attempts to operate upon a left-sided hernia while standing to the right of the patient. In such instances the needle is passed first through Poupart's ligament, and then through the muscles; when this is done, the needle is apt to pass deeper than one desires.

11. Chronic Inflammatory Swellings.—German authors (Schloffer, 58) describe the formation of a chronic inflammatory swelling within or in the neighborhood of the cicatrix. This is a late complication. These inflammatory swellings make their appearance a long time, even years, after the operation, and appear to be due to infection around the silk ligature or suture with an organism of a low degree of virulence. There results an extensive exudate, with little pus formation. An incision and removal of the exudate may become necessary.

CAUSES OF FAILURE

Although the operation for the radical cure of hernia is comparatively simple, recurrences occur even in the best of hands. It is important, therefore, to investigate carefully the cause or causes of failures. In order to appreciate these causes at their true value, a brief summary of the principles underlying the radical cure of hernia is necessary.

On theoretical grounds no inguinal hernia is curable, unless the testis is sacrificed. As long as an opening must be left for the escape of the spermatic cord through the transversalis fascia, there remains a weak area, through which a recurrence becomes possible. The surgeon gets around the difficulty by building a buttress in front of this weak area from the muscular and fascial structures in the neighborhood.

During the past few years I have paid much attention to the question of recurrence after various attempts at radical cure. As a result of these studies I have formulated certain conclusions which, in some particulars, differ from those commonly held. The following are, in my experience, the most common causes of recurrence.

1. Incomplete Isolation of the Sac.—In other words, the sac was not ligated sufficiently high, leaving behind a smaller or larger dimple, affording an excellent starting point for the development of another hernia.

2. Slipping of the Ligature.—This was demonstrated in at least two cases re-operated upon by me. This deduction was drawn, because the hernial contents were not covered by any parietal serosa, being buried in a mass of loose adhesions. Only near the neck of the sac was any serosa present and this was normal in appearance.

3. Failure of Removal of the Sac.—Failure to dissect out and ligate the sac has been a not uncommon cause of recurrence, especially in the past, when the belief obtained among some surgeons that it was not necessary to remove a small sac. This happened particularly when the surgeon performed a bilateral operation, the patient having a manifest hernia on one side, while the other side was operated upon "prophylactically." Upon the second side either no search was made for a sac, or, if one was found, it proved so small that it was not considered worth extirpation. Nevertheless, these minute sacs invariably are the starting points for a recurrence. I do not approve of the indiscriminate bilateral operation for hernia. The radical cure of a hernia should not be done unless a hernia is actually demonstrable.

4. **Injudiciously Selected Suture Material.**—A very frequent finding, when operating for a recurrence of an inguinal hernia, is the following: After opening a linear scar, the manifest evidence of primary union, the aponeurosis of the external oblique is found slightly adherent to the superposed and subjacent structures, and perfectly intact. The internal oblique and transversalis muscles are found in their normal anatomical positions; a few slight cicatricial adhesions may be present between these muscles and Poupart's ligament. Otherwise, the union of these structures has completely failed. There can be no question whatever that the operation was correctly done.

To what reasons can this failure of union be ascribed? There are only 3 possibilities. 1. The knots may have become untied; this is not probable because surgeons are careful to tie their sutures well. Furthermore, even assuming that one or even two of the sutures had loosened, it is hardly probable that all should be loosened. 2. The sutures may have been tied too tightly, thereby strangulating the tissues, or they may have cut through the muscles. If this happened, we should expect some scar tissue, or at least degenerated muscle; such, however, is not found. 3. The sutures may have been absorbed before firm union had taken place between the attached muscles and Poupart's ligament. This, in my opinion, is the only logical explanation. This is the reason why I advocate Pagenstecher's linen thread instead of chromicized catgut. I have no hesitancy in stating that the universal adoption of a more resistant suture material will be followed by a distinct improvement in the statistics bearing upon the radical cure of a hernia.

Pólya (55), in a recent article upon the causes of recurrence after radical operation for inguinal hernia, draws a similar conclusion.

For the same reasons, I emphatically condemn all operations for the radical cure of inguinal hernia in which complicated methods of suture, requiring subsequent removal of the stitches, are advocated.

5. **A Badly Selected Operation.**—A badly selected operation is not infrequently followed by a recurrence. Some surgeons perform a certain type operation in all cases. As I shall point out, a uniform operation is not applicable for all cases. Some cases require transplantation of the cord, others do not. Each case must be studied, and the necessary operation must be selected accordingly.

6. **Infection of the Wound.**—Infection of the wound, particularly of the leeper parts, is followed by extrusion of the sutures long before union beween the muscles and Poupart's ligament has taken place. In such a case ecurrence is very apt to occur. Slight infection of the superficial structures as no bearing upon the possibility of recurrence.

Results

In the introduction, the value of published statistics was criticized for the eason that, in most instances, they are not correctly reported. In order to e of value statistics should include the following data:

1. Time clapsed since the operation. No case operated within 2 years should be reported as cured.
2. The patient's own statement, that he believes himself cured, should not be accepted. An examination by a competent surgeon is the only valid test.
3. The age and sex of the patient must be considered. For instance, hernia in children is more easily cured than in the adult; while oblique inguinal hernia in females is more easily cured than in males.
4. The size of the hernia is manifestly of importance in statistical studies.
5. The nature of the operation must be taken into consideration.

These requirements are difficult to obtain, especially in certain portions of the United States, where the population is constantly moving. It is, therefore, hard to trace postoperative cases.

In general, it may be stated that published statistics vary, as to the number of recurrences, from 1 to about 8 per cent. I am convinced that, if all cases were tabulated correctly, the percentage of recurrences would be considerably higher than those given.

DIRECT INGUINAL HERNIA

SURGICAL ANATOMY AND PATHOGENESIS

Every hernia which makes its escape from the abdomen on the mesial side of the deep epigastric artery, is called a direct inguinal hernia. The space through which it passes is bounded internally by the edge of the sheath of the rectus muscle, externally by the deep epigastric vessels, and below by Poupart's ligament. The floor of this space is formed solely by the transversalis fascia, directly behind which are the properitoneal fat (here always present) and the peritoneum. Its immediate anterior coverings are the intercolumnar fibers and fascia covering the external inguinal ring. It is evident, therefore, that the coverings of such a hernia must be

1. Peritoneum and properitoneal fat.

2. Transversalis fascia.
3. Intercolumnar fascia.
4. Skin, superficial fascia, and subcutaneous fat.

In very rare instances the hernia escapes from the abdomen at a somewhat higher level, and either makes its exit through a hiatus in the internal oblique muscle or pushes this muscle ahead. In the latter instance, the internal oblique muscle must be added to the coverings.

A direct inguinal hernia is usually small; in fact, it is only in the rarest instances that such a hernia descends into the scrotum. The peritoneal sac is even considerably smaller than the size of the hernial mass would lead one to believe, because a good part of the protrusion consists of properitoneal fat, which, as compared to the amount found in oblique inguinal hernia, is very abundant in this region. The observations made for oblique inguinal hernia, in regard to the proximity of the bladder, apply with still greater emphasis to direct inguinal hernia. It is particularly in this variety of hernia that the bladder runs grave danger of being injured.

ARTIFICIAL HERNIA

This hernia, which, for want of a better name, I have called "artificial" hernia, is a variety of direct inguinal hernia, and is especially common in New York City among Russian Jews, who have had these herniæ made artificially, in order to escape military duty. The modus operandi is approximately the following. At the age of conscription the willing victim is blindfolded and placed upon the floor, the operator, who makes a business of this proceeding, invaginates his finger into the scrotum and external inguinal ring, and violently forces his finger directly backward until something gives way; this step is usually accompanied by great pain. The victim is then given an emetic, consisting most frequently of an emulsion of yeast, and in addition is ordered to use strong snuff *ad libitum.* Within 2 or 3 days after the operation a hernia develops.

I have operated upon a number of these cases, and have always found a direct inguinal hernia, with a tear in the transversalis fascia covering Hesselbach's triangle. The prognosis and treatment are the same as for direct inguinal hernia.

Artificial hernia has been very carefully studied by Russian surgeons, who, of course, have the greatest opportunity to do so. The nature of the injury has been defined in the living subject and also experimentally by Krymow (35). In this country cases have been reported by A. G. Gerster, Coley, Parker Syms, and myself.

There is still another form of hernia which may, with propriety, be classified under the heading of artificial hernia. I refer to herniæ which follow an Alexander's operation for shortening of the round ligaments. While a simple affair, this hernia is not as easily explained as may appear on first sight.

Gynecologists explain the hernia as arising from an injury and destruction of the aponeurosis of the external oblique muscle; for this reason they are careful not to incise this structure, the operation being done entirely within the confines of the external inguinal ring. I believe this explanation is erroneous, and offer 2 other explanations; both of which I have been able to verify at operation.

1. The afflicted individual had already a potential congenital hernia. In other words, the round ligament made up a part of the wall of the sac, and the hernia only became apparent when the round ligament was pulled out for the purpose of shortening it. In this form, the hernia is of the oblique variety.

2. There must have occurred during the operation an injury or infection of the transversalis fascia covering Hesselbach's triangle, because the hernia is a direct inguinal one.

In both instances the aponeurosis of the external oblique muscle was found normal.

TREATMENT OF DIRECT INGUINAL HERNIA

As a rule, no special methods are given for the operative treatment of direct inguinal hernia. This I believe is an error; a distinction should be made in the treatment of an indirect and direct inguinal hernia. This brings up the following question:

When Should the Cord Be Transplanted?—Figure 10 is a diagrammatic cross-section of the inguinal region taken through the 2 inguinal rings, to indicate the anatomy of the 2 forms of herniæ which occur in this region; namely, direct and indirect. It is seen that the internal inguinal ring (site of exit for an oblique inguinal hernia) is situated on the outer side of the deep epigastric artery. It is somewhat overlapped by the internal oblique and transversalis muscles, and wholly by the aponeurosis of the external oblique, and is situated at some distance upward and outward from the external inguinal ring. Furthermore, it is evident that the internal opening of a direct inguinal hernia (corresponding to the internal inguinal ring in an oblique inguinal hernia) lies to the inner side of the deep epigastric vessels, directly behind the external inguinal ring; and is practically without any protection, unless one chooses to call the spermatic cord and the delicate intercolumnar fascia such.

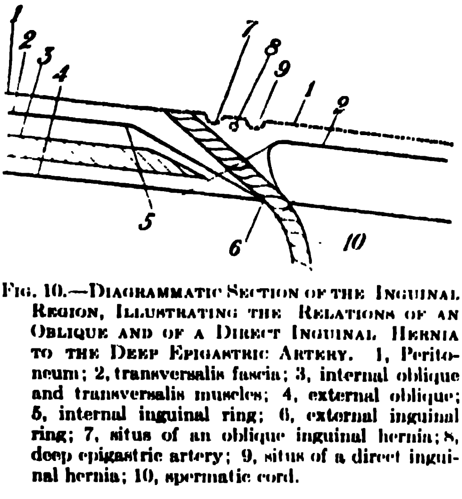

FIG. 10.—DIAGRAMMATIC SECTION OF THE INGUINAL REGION, ILLUSTRATING THE RELATIONS OF AN OBLIQUE AND OF A DIRECT INGUINAL HERNIA TO THE DEEP EPIGASTRIC ARTERY. 1, Peritoneum; 2, transversalis fascia; 3, internal oblique and transversalis muscles; 4, external oblique; 5, internal inguinal ring; 6, external inguinal ring; 7, situs of an oblique inguinal hernia; 8, deep epigastric artery; 9, situs of a direct inguinal hernia; 10, spermatic cord.

Now in order to build the proper buttress at the site of the weakest part of the abdominal wall, the *logical procedure would be to put our buttress to the mesial side of the deep epigastric artery in the direct hernia, and to* the outer side of this vessel in the oblique variety. The problem remains: How had this best be done?

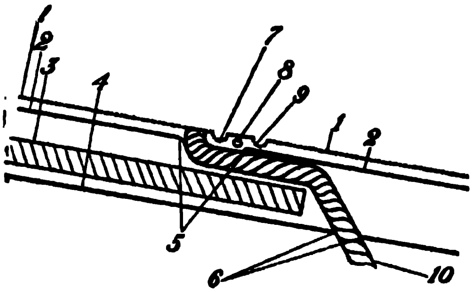

Fig. 11.—Cross-section of an Operation for the Radical Cure of an Inguinal Hernia, Without Transplantation of the Cord. (Ferguson-Coley.) 1, Peritoneum; 2, transversalis fascia; 3, internal oblique and transversalis muscles; 4, external oblique; 5, internal inguinal ring; 6, external inguinal ring; 7, situs of an oblique inguinal hernia; 8, deep epigastric artery; 9, situs of a direct inguinal hernia; 10, spermatic cord.

Figure 11 illustrates an operation for the cure of inguinal hernia, without transplantation of the cord, and Figure 12 one with transplantation of the cord.

In all operations for inguinal hernia, as has been shown in a previous chapter, the internal oblique and transversalis muscles are sutured, for a greater or lesser distance, to Poupart's ligament. When the cord is transplanted, the line of attachment extends from the point of emergence of the spermatic cord, underneath the internal oblique muscle, down to the spine of the pubis. When the cord is not transplanted, the line of attachment extends from the point of origin of the internal oblique and transversalis muscles to a short distance from the spine of the pubis, leaving an opening for the escape of the spermatic cord into the scrotum.

Let us now examine on Figure 12 the site of exit of an oblique inguinal hernia. We note the hole in the transversalis fascia through which the spermatic cord escapes. In this case a typical Bassini operation with transplantation of the cord was done, with suture of the muscles to Poupart's ligament; of necessity a hole was left for the exit of the cord. In other words, the hole in the transversalis fascia still remains, and all that we have really accomplished is to increase the depth of this hole. This "hole" really represents a cylindrical hollow, very shallow, its wall being composed merely of the thickness of the transversalis fascia. By suturing the muscles to Poupart's ligament, this shallow section of a cylinder is deepened to the extent of the thickness of the sutured muscles; but a literal

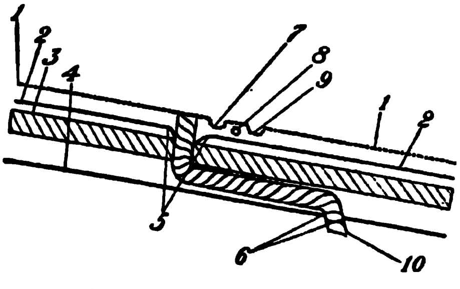

Fig. 12.—Cross-section of an Operation for the Radical Cure of an Inguinal Hernia, with Transplantation of the Cord. (Bassini.) 1, Peritoneum; 2, transversalis fascia; 3, internal oblique and transversalis muscles; 4, external oblique; 5, internal inguinal ring; 6, external inguinal ring; 7, situs of an oblique inguinal hernia; 8, deep epigastric artery; 9, situs of a direct inguinal hernia; 10, spermatic cord.

closure of this "hole" or cylinder is not thereby accomplished. Over this opening finally is sutured the aponeurosis of the external oblique; and, to my mind, this aponeurosis of the external oblique is the only structure that really occludes the hiatus. It is apparent, however, that this operation very materially fortifies the space to the mesial side of the deep epigastric artery. It follows, therefore, that this is evidently not the best operation for oblique inguinal hernia, but is the one of choice for direct inguinal hernia.

Finally let us turn to Figure 11. Again we see the hole in the transversalis fascia through which the cord emerges. In this operation, however, the cord was not transplanted. The cord was not disturbed at all, only the internal oblique and transversalis muscles being sutured over it to Poupart's ligament; above this, as in all other operations, the divided aponeurosis of the external oblique was sutured. It is true that in this case, also, we are compelled, of necessity, to leave an opening for the escape of the spermatic cord into the scrotum; but we place this opening downward and inward, at some distance from the internal inguinal ring, where it does not interfere with the buttress in front of the internal inguinal ring. Keeping these points in mind, it becomes evident that this must be the operation of choice in oblique inguinal hernia, but not in the direct variety.

The question of transplanting the cord or not, therefore, resolves itself into the following:

1. Transplant in direct inguinal hernia.
2. Do not transplant in oblique inguinal hernia.

Attention was first drawn to this important fact by me in 1911 (40). Since that time these facts have been accepted generally.

It is needless to mention that the Andrews' modification, wherein the deep sutures include not only the internal oblique and transversalis muscles, but also the aponeurosis of the external oblique, can be modified according to both indications.

RECURRENT INGUINAL HERNIA

The treatment of recurrent inguinal hernia, as far as the operation is concerned, is that of the primary hernia. There are, however, a few minor distinguishing features to which attention must be called.

The preparation of the operative field, prior to the isolation and extirpation of the sac and the introduction of the deep sutures, is apt to be difficult and tedious, on account of extensive adhesions. It is important to remove all the cicatricial tissue, so that the normal anatomical landmarks shall be in perfect evidence. I emphasize the necessity of never proceeding to the plastic part of the operation until there is a perfect exposure of the normal anatomical structures and relations. Especial care is required in the isolation of the sac, as injuries, particularly to the vas deferens, are likely to happen.

The operation in other respects does not differ from that for the primary hernia.

The prognosis for the cure of a recurrent inguinal hernia is just as good as after a primary operation.

SUBVARIETIES OF INGUINAL HERNIA

Oblique inguinal hernia has numerous subvarieties. If critically examined, these varieties fall into two groups, viz.:

I. Anomalies of the hernial sac.
II. Anomalies of the hernial contents.

I. ANOMALIES OF THE HERNIAL SAC

1. Congenital Inguinal Hernia

Anatomy and Pathogenesis.—The name "congenital inguinal hernia" is, to my mind, a misnomer. First, because, according to some authors, all inguinal herniæ are congenital, and this name is, therefore, not sufficiently distinctive. Secondly, because we occasionally meet with herniæ that are really congenital, in as far as they are antenatal in origin, or were noticed immediately or shortly after birth; nevertheless, they are not of the type included under the term "congenital inguinal hernia." Thirdly, because by the word "hernia" we mean a peritoneal sac plus its contents. Yet some patients have a sac of distinctly congenital type, which, nevertheless, harbored no contents until late in life. In other words, a hernia of this variety is really not congenital; all that is congenital is the sac. But this name has become a convention, and for our purpose will be retained. Indeed, there is no harm in its perpetuation, provided one always remembers, first, that there are other congenital herniæ, which are not of this variety, and, second, that it is only the sac which is congenital, while the hernial contents may be acquired.

Anatomically the difference between a congenital and an acquired hernia is the following. As is well known, the testis in its descent into the scrotum, is always accompanied or even preceded by an outgrowth of the peritoneum, that has received the name of *processus vaginalis peritonei.* After the descent of the testis, the peritoneum becomes shut off at the internal inguinal ring and just above the testis. The intervening portion becomes obliterated and remains as a fine cord-like structure within the confines of the spermatic cord; the distal portion persists and becomes the tunica vaginalis.

This obliteration is subject to various maldevelopments; with one of these we are now dealing. Let us assume the following condition; the testis has fully descended into the scrotum, accompanied by the normal processus vaginalis, but here the course of normal development has ceased; i. e. the processus vaginalis has failed to become shut off at both the testicular and the abdominal ends (Fig. 13), nor has the intervening portion become obliterated.

It is evident, therefore, that we have here a complete hernial sac, which communicates above with the general peritoneal cavity. This is the variety known as "congenital inguinal hernia," though manifestly the sac alone is strictly congenital; hernial contents may find their way into the sac before, during, or soon after birth. On the other hand, hernial contents may not find their way into the sac until late in life; perhaps never.

Anatomically there are certain other well-marked differences between a congenital hernia and an acquired hernia. The sac of a congenital hernia is very apt to be exceedingly thin, so that its isolation is decidedly more difficult, particularly in the region of the neck. The isolation is rendered more difficult by the further fact that not infrequently the component parts of the spermatic cord are not gathered into a distinct strand, but are spread out over a wide area of the sac. Not infrequently there are to be seen ridges or elevations within the lumen of the sac, that are very probably incomplete attempts on the part of nature to affect an obliteration. These may be the causes of a subsequent strangulation, that are, therefore, entirely intrasaccular, as opposed to the usual extrasaccular causes of strangulation. I have described two such instances (11). Since then I have seen another case.

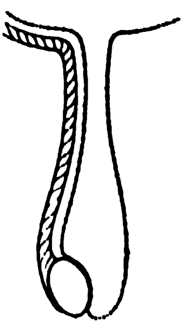

FIG. 13.—DIAGRAM ILLUSTRATING THE SAC OF A CONGENITAL INGUINAL HERNIA.

It is manifest that in male patients the recognition of a congenital hernia is very easy, after the sac has been opened. The presence of the testis within the sac stamps it immediately as such. In the female, however, this diagnostic mark is absent. Nevertheless, it is just as important to recognize congenital herniæ in the female sex as in the male.

In females the processus vaginalis is called the canal of Nuck, and as in the male this canal becomes obliterated and remains as a thin cord accompanying the round ligament. Failure of obliteration of the canal of Nuck may give rise to a congenital inguinal hernia. Its recognition and differentiation from an acquired hernia are very difficult. I have found that the only means of recognizing a congenital inguinal hernia in the female is the intimate adherence of the sac to the round ligament.

Indeed this adhesion is so close that attempts to dissect it free usually result in a shredding of the sac. If such a sac is traced upward, it will be found to be directly continuous, on the mesial side, with the serosa covering the uterus.

Treatment.—The treatment of a congenital inguinal hernia differs from the treatment of an acquired one only in the manipulation of the sac.

The isolation of the sac may be exceedingly difficult, particularly in young children, because of its exceeding thinness and the frequent spreading out of the structures of the cord over a large part of the sac. Great care is, therefore, required; otherwise the sac is torn, making its complete isolation and ligation a difficult problem. After the sac has been isolated, it may be dealt with in different ways.

1. The sac is ligated at the internal inguinal ring, the rest is everted and sutured, as in the Winkelmann operation for hydrocele. When the procedure is finished, the serosa lies everted, and is in contact with loose cellular tissue.
2. The sac is ligated at the internal inguinal ring, cut off at the testicular end, and sutured there, so as to form a new tunica vaginalis. The intervening portion is extirpated.
3. The sac is ligated at the internal inguinal ring, and is then dissected away as far as its attachment to the testis. I prefer the last method. There is no advantage, as a large experience has demonstrated, in the constructing of a new tunica vaginalis.

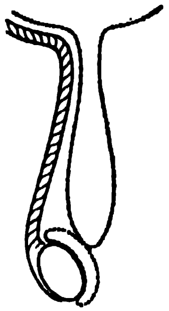

FIG. 14.—DIAGRAM ILLUSTRATING THE SAC OF A HERNIA INTO THE FUNICULAR PROCESS. Note the intimate connection between the fundus of the sac and the tunica vaginalis.

2. HERNIA INTO THE FUNICULAR PROCESS

We have seen that in "congenital hernia," so-called, the vaginal process, formed during the descent of the testis, has not been shut off anywhere throughout its extent. Let us now assume that the vaginal process is shut off at its inferior extremity only, forming a normal tunica vaginalis; while the remainder of the canal remains patent. We are then dealing with a "hernia into the funicular process" (Fig. 14).

Hernia into the funicular process differs from an ordinary acquired scrotal hernia in that the lower end of the sac and the tunica vaginalis are intimately adherent, while in an acquired scrotal hernia this part of the sac is free. In the hernia into the funicular process, therefore, the tip of the sac must be separated from the tunica vaginalis by sharp dissection; this occasionally results in opening up of the tunica vaginalis, an injury of no consequence whatever.

For precision's sake, it may be added that another difference between a hernia into the funicular process and an acquired scrotal hernia exists in the fact that in a hernia into the funicular process the slender fibrous structure, the remains of the obliterated processus vaginalis, is wanting.

The treatment of a hernia into the funicular process, with the exception of the necessary sharp dissection of the inferior extremity of the sac from the tunica vaginalis, does not differ from that of an ordinary acquired inguinal hernia.

3. Encysted Hernia

Let us now assume that, instead of the distal, the proximal end of the processus vaginalis has been shut off, the remainder of the sac remaining unobliterated. If a hernia now occurs, it is evident that a portion of the peritoneum lining the general peritoneal cavity will protrude into a completely shut off serosal sac. This variety of hernia has received the somewhat ambiguous name "encysted hernia" (Figs. 15, 16).

In operating upon such a case, one is surprised, upon incising the sac, to find at first no hernial contents; indeed, not even a communication with the general peritoneal cavity is found. If this sac is now extirpated (a somewhat difficult matter at its upper extremity), or if its posterior wall is incised, we are again surprised to find another sac, which is the true sac of the hernia.

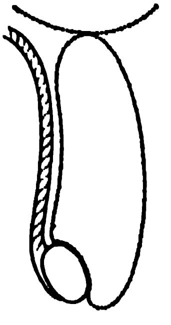
Fig. 15.—Diagram Illustrating the Condition Prior to the Formation of an Encysted Hernia.

This hernia differs from the ordinary acquired hernia, first, in the presence of the extra sac, in which the testis is embedded, and, second, in the difficulty of extirpating the sac, especially at its upper extremity, where it is adherent to the distal extremity of the true hernial sac.

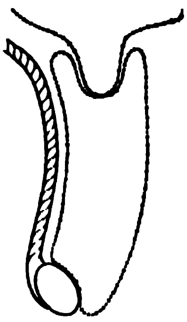
Fig. 16.—Diagram Illustrating the Condition After the Formation of an Encysted Hernia.

This form of hernia is very rare, and is even more rarely diagnosticated before operation. Its main interest lies in the peculiar development of the hernia.

Treatment.—With the exception of the peculiarity of the 2 different sacs, which may cause trouble in their recognition, and a slight difficulty in their isolation and extirpation, the treatment of an encysted hernia does not differ from that of an ordinary acquired inguinal hernia.

4. Infantile Hernia

The term "infantile hernia" is another misnomer. Some authors describe a hernia in which the maldevelopment is practically identical with that of an encysted hernia; but the hernial protrusion, instead of becoming invaginated into the preformed lower sac, descends behind it; to this form they have applied the vague term "infantile hernia" (Fig. 17).

I see no necessity for this subdivision; there is no material difference between the two forms of hernia.

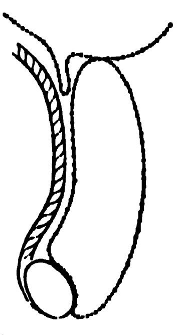
Fig. 17.—Diagram Illustrating the Sac of an Infantile Hernia.

5. Hernia Complicated with Hydrocele

Hydrocele as a complication of hernia is met with frequently, and in one form may be puzzling to the inexperienced.

When any shut-off portion of the peritoneum is so diseased as to exude serum in excess of the normal, the resulting cyst is called a hydrocele. It has been repeatedly mentioned that, in the normal descent of the testis, *certain portions of the processus vaginalis peritonei* become normally or abnormally shut off; any portion may thus come to harbor a hydrocele effusion. We may, therefore, have the following varieties.

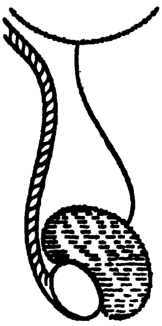
FIG. 18.—DIAGRAM ILLUSTRATING A HYDROCELE OF THE TUNICA VAGINALIS.

Varieties.—(a) The normal process. The processus vaginalis is shut off at its abdominal and testicular ends, while the intervening portion becomes obliterated. There is left a shut-off portion of the peritoneum at the testicle. This, if filled with an excess of serum, forms a "hydrocele of the tunica vaginalis testis" (Fig. 18).

(b) The processus vaginalis fails to become shut off at either end, and remains, therefore, in open communication with the general peritoneal cavity. If a hernia forms it is called a "congenital inguinal hernia"; if only an excess of serum is present, it is called a "hydrocele communicans." This variety has also a number of subvarieties; their discussion, however, would lead us too far (Fig. 19).

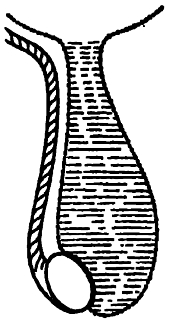
FIG. 19.—DIAGRAM ILLUSTRATING A HYDROCELE COMMUNICANS.

(c) The processus vaginalis becomes shut off at its upper end only, the lower end remains open, while the remainder is unobliterated. If a hernia now forms, it is called an "encysted hernia." The condition associated with an excess of serum into such a sac has not received a distinctive name, being difficult of differentiation from an ordinary hydrocele of the tunica vaginalis. Only at operation can this be determined, differentiation depending upon the fact that the extirpation of the sac of the hydrocele, at its upper extremity, can only be accomplished by sharp dissection (Fig. 20).

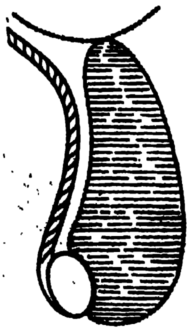
FIG. 20.—DIAGRAM ILLUSTRATING AN ENCYSTED HYDROCELE.

(d) Finally the processus vaginalis may become shut off at both ends, while the intermediate portion is not obliterated, or is obliterated only in parts, so that either one large sac, or 2 or more small saccules, persist. If an exudation takes place into these sacs, we have before us a condition that has received the name of "hydrocele of the cord" (Fig. 21).

Treatment.—Any of these varieties may be encountered in an operation for inguinal hernia. Various methods of treatment have been proposed for them. At present 2 vie with each other for favor. 1. Incision and suture of the sac behind the cord or testis, so that the everted serosa lies in contact with loose cellular tissue. 2. Total extirpation. I am decidedly in favor of the second operation, because it is no more difficult than the first, it consumes little or even less time, and finally it is radical. Numerous recurrences after the first type of operation have been reported, both by myself and others.

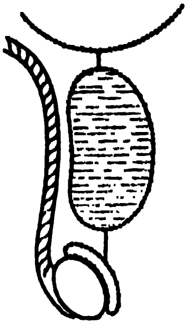

Fig. 21.—Diagram Illustrating a Hydrocele of the Cord.

6. Hernia Complicated by Imperfect Descent of the Testis

Oblique inguinal hernia is, in a certain percentage of the cases, accompanied by an imperfect descent of the testis; conversely an imperfect descent of the testis is nearly always accompanied or complicated by a hernia. Inasmuch as this is a rather common condition, the matter will be treated at some length.

The etiology of this condition is not established. There are many theories, but none is satisfactory. Our lack of definite knowledge is easily understood when we consider that there is not even a correct explanation of the normal descent of the testis. Of greater moment is a correct knowledge of the anatomy of the imperfectly descended testis.

Anatomical Varieties.—There are a number of varieties of the imperfectly descended testis, and the anatomy of the parts varies accordingly.

A. NON-DESCENDED TESTIS.—It is important to remember that the primary genital anlage of the testis is placed in close proximity to the primitive kidney. Before reaching its ultimate resting place in the bottom of the scrotum the testis must pass along the posterior abdominal parietes, through the inguinal canal and upper part of the scrotum. The testis may be arrested in any part of its course, and, in consequence, the following anomalies may be met with:

1. The Abdominal Non-descended Testis.—The testis is arrested proximally to the internal inguinal ring.

2. The Inguinal Non-descended Testis.—The testis is arrested in the inguinal canal.

3. The Pubic Non-descended Testis.—The testis is arrested just beyond the external inguinal ring, i. e. in front of the pubic bone.

4. The Upper Scrotal Non-descended Testis.—The testis is arrested in the upper part of the scrotum.

B. MALDESCENDED TESTIS.—This variety differs from the preceding in the important fact that the testis is not arrested anywhere in its course. The organ is extruded through the external inguinal ring like a normal testis; at this point, however, it fails to take its proper course into the scrotum, and is deflected into other directions. When this occurs, we may have the following types:

1. The Inguino-superficial Maldescended Testis.—The testis, after its extrusion from the external inguinal ring, is deflected upward and outward

and lies upon the aponeurosis of the external oblique muscle, between it and the deep layer of the superficial fascia.

2. THE CRURAL OR CRURO-SCROTAL MALDESCENT OF THE TESTIS.—The testis lies in the upper part of Scarpa's triangle, or more frequently in the angle formed by the thigh and scrotum.

3. THE PERINEAL MALDESCENDED TESTIS.—The testis, after its extrusion from the inguinal canal, migrates into the perineum.

4. TRANSPOSITION OF THE TESTIS.—In this exceedingly rare condition, the testis of one side migrates intraperitoneally, and is extruded, through the opposite inguinal canal, into the opposite scrotal half. While this in effect is also a maldescent, it is not so in the strictest sense. Berg (7) and Halsted (22) each report one case of this anomaly. One further case is mentioned, without any reference, in the "Handbuch für Chirurgie." I was fortunate in having been able to observe the case of Dr. Berg.

Anatomy of the Non-descended Testis.—The following description is based upon an extended experience in a large series of cases (Moschcowitz, 49).

1. THE BODY OF THE TESTIS.—The body of the testis is usually small; at most, from 1/3 to 1/2 the normal size. The organ is distinctly softer than normal. On compression the testicle still imparts the subjective sensation known as "testicular feeling." The determination of this feeling is important in the diagnosis of the position of the testis, particularly when the anomaly is accompanied by a large omental hernia. In a great majority of cases the testis has a distinct mesentery, allowing considerable mobility, particularly in a lateral direction.

2. THE EPIDIDYMIS, as a rule, is well developed, but is not infrequently separated from the body of the testis.

3. THE VAS DEFERENS.—The vas deferens is **always of ample length.** The greatest emphasis must be laid upon this point, because of its important bearing upon the operative treatment. In fact, in many instances the vas deferens is unusually long, and may extend to the bottom of the scrotum in the form of a loop, even though the testis and epididymis are retained within the abdomen.

In regard to this point, emphatic exception should be taken to a much quoted statement of Katzenstein (30), who says that most operations for cryptorchismus are failures, because the very elastic and short vas deferens retracts the testis after it has been anchored in the scrotum. He attempts to prove his contention by attaching weights to equal lengths of spermatic vessels and vas deferens, isolated from the same spermatic cord. No one doubts that this experiment will prove the greatest elasticity and resistance of the vas; but it is utterly fallacious to deduce from this experiment that the vas deferens is too short in non-descended testes, or that it is the cause of failures after operations for their relief.

4. THE PROCESSUS VAGINALIS.—The processus vaginalis, as a rule, is in open communication with the general peritoneal cavity, forming a sac, which may lead to a so-called "congenital inguinal hernia." I have heard of only

one case in which there was an undescended testis with a perfect tunica vaginalis and no accompanying hernia.

In approximately half of the cases, particularly in those accompanied by large herniæ, the vaginal process extends to the bottom of the scrotum. Emphasis is laid upon the point that in about half of the cases the vaginal process *does not* extend to the bottom of the scrotum. There is a divergence of views between the embryologist and the surgeon in regard to this observation. The embryologist alleges that the testis is always preceded in its descent by an outgrowth or prolongation of the peritoneum into the scrotum. Were this true, we should have no difficulty in demonstrating the prolongation in every case of undescended testis. As a matter of fact, we fail to find this prolongation except in cases that are accompanied by a scrotal hernia of considerable size. It is very probable that in these cases the prolongation is pushed to the bottom of the scrotum by the advancing hernia, and was not a preëxisting entity.

Much stress has been laid by some surgeons upon the vaginal process as an obstacle to the bringing down of the testis at operation. I believe this view to be erroneous, for the following reasons:

1. It does not take into consideration the different lengths of the sac. 2. The testis is in reality a retroperitoneal organ, and its motility cannot, therefore, be affected by something outside of it. 3. Even when the neck of the sac is freed and ligated, the testis is no nearer to the bottom of the scrotum than before. 4. A practical and important reason is that at operations the sac does not cause the slightest difficulty in mobilizing the testis.

The peritoneum forming the vaginal process, even when accompanied by old and large herniæ, is exceedingly thin and delicate, requiring cautious dissection for its isolation.

5. THE SPERMATIC CORD.—The spermatic cord is not gathered into a normal cord-like structure, but is spread out fan-shape over a considerable area. The vas deferens, as a rule, lies somewhat apart from the other components of the cord. The spreading out of the structures and the thinness of the serous membrane make the dissection and isolation of the sac a step of unusual delicacy.

6. THE SPERMATIC VESSELS. The spermatic vessels are poorly developed. Both the veins and the spermatic artery possess a caliber smaller than normal. When the spermatic artery is cut, the bleeding is slight or, at all events, less than normal. It is possible that the small size and softness of the testis are due to this hypoplasia of the blood-vessels.

We now come to one of the most important observations in regard to the anatomy of the non-descended testis. It is this: **The spermatic vessels are deficient in length,** apparently to the extent of the distance between the testis and the bottom of the scrotum. Whether this shortness is due to a congenital hypoplasia, it is impossible to state with certainty; it would also carry me into the realms of speculation, were I to decide offhand the question whether the non-descent of the testis is due to the shortness of the vessels, or whether the shortness of the vessels is caused by the non-descent of the testis. Arguing by analogy, similar anomalies have been noted in malpositions of other organs, e. g. malpositions of the kidney; and while I have no absolute proof, I am inclined, for want of a better theory, to assume that the non-descent is in a great measure due to the shortness of the spermatic vessels.

It is self-understood that in this place only undescended testis is referred to; for in the maldescended organ the blood-vessels are of sufficient size and length.

7. THE SCROTUM.—The scrotum varies in size; this variation, I have found, depends upon the presence or absence of a hernia. If a hernia is present, the scrotum is large, its size depending upon the size of the hernia. Some writers lay considerable stress upon the non-development of the scrotum, both as a cause of the non-descent of the testis and as a cause of the inability to anchor the testis properly. Both of these assumptions, however, are erroneous; first, because the scrotum accommodates itself readily to any size, whether to that of a hernia or to that of one or both testes; and, second, because the embryological development of the scrotum is independent of that of the testes.

Anatomy of the Maldescended Testis.—The anatomy of the maldescended testis differs both from the testis normally situated within the scrotum, and from the non-descended testis in that it is normal in every respect; i. e. the testis is of normal size and the vessels are also of normal size and length. The fact that the maldescended testis is nearly always accompanied by a hernia produces a condition similar to a so-called "congenital" hernia. As both the vessels and vas deferens are of ample length, there is no difficulty in transplanting the testis into the scrotum.

The regional anatomy of the maldescended testis depends upon the variety dealt with. Its detailed description is beyond the scope of this article.

Indications and Reasons for Operating upon Undescended and Maldescended Testes.—1. Every undescended testis is accompanied by a hernia, either actual or potential. Furthermore, the application of trusses is either impossible or painful to these herniæ. The use of a forked truss has not proved serviceable in my hands.

2. The undescended testis is more subject to trauma than the normally situated testis.

3. It is important to remember that the testis possesses 2 physiological functions: (a) elaboration of spermatozoa, (b) the maintenance of sex characteristics. The burden of belief seems to be that in an undescended testis the spermatogenetic function is either totally absent or reduced to a minimum. This has been ably proven by Haines, who showed, in a convincing study, that in pigs in which undescended testes are very common, the spermatogenetic cells are absent. On the other hand, he showed that the interstitial

and Sertoli cells, which he believes bear important relations to the maintenance of sex characteristics, are preserved and are enormously increased in number. The preservation of the second function is, therefore, a paramount indication for a conservative operation for an undescended testis, especially in the young.

4. It is alleged by many that the replacement of the testis within the scrotum restores its spermatogenetic function; but this is still a mooted question. While this belief does not appear to be very probable even the possibility of restoring this function is a strong argument in favor of operative replacement.

5. The not infrequently observed development of malignant tumors in non-descended testes should also be considered as an indication for operation.

6. An undescended testis is peculiarly liable to certain accidents that frequently threaten or destroy its viability. Reference is here made particularly to torsion of the spermatic cord. De Quervain (11) describes a peculiar accident in undescended testes, in which either the body of the testis or its cord becomes strangulated by the pillars of the external inguinal ring.

7. Extension of a gonorrhea to a scrotal testis or its metastatic involvement in mumps is sufficiently distressing, but these conditions in an undescended testis are very grave and may even menace the patient's life.

8. A minor reason, and yet not a negligible one, is the psychic depression under which adults suffer when only one, or, worse still, neither testis has reached the scrotum.

9. In maldescended testis sufficient indications for operation are the presence of the congenital hernia that accompanies the malposition, and the liability to the various accidents, trauma, etc., that have been described in connection with the non-descended testis.

Treatment.—A patient with an undescended testis is to be regarded as cured only if the testis remains permanently in the bottom of the scrotum, and if the accompanying hernia is cured. I have seen cases of so-called "cure" of an undescended testis, where the testicle was high up in the scrotum and sometimes even in front of the pubis. To call such cases "cures" is in my view an evidence of a deplorable degree of complacency.

I have successively tried nearly all methods of treatment that have been recommended. I will also show why these methods have largely been failures in my hands, and why I have finally settled upon the Bevan operation as most satisfactory of all.

1. LANGENBECK'S METHOD.—One of the first methods of treatment for undescended testis was that advocated by Langenbeck. This consisted in massage, manipulations, and the application of a forked truss, to prevent the testis from slipping back. I have tried this method faithfully in a number of cases where, for justifiable reasons, operation could not be recommended, but have seen no benefit. The truss causes much discomfort and fails to retain the

hernia satisfactorily. The method is, therefore, not curative, either to the non-descended testis or to the accompanying hernia.

2. ORCHIDECTOMY.—The objections to orchidectomy are obvious.

3. REPLACEMENT OF THE TESTIS WITHIN THE ABDOMEN.—Replacement of the testis within the abdomen, with closure of the internal inguinal ring, has been recommended. The hernia is cured, it is true, but the operation does not obviate the other dangers associated with a non-descended testis; moreover, it is certainly not cosmetic.

4. LENGTHENING THE VAS DEFERENS.—On the theory that the maldescent was due to a shortness of the vas deferens, I attempted, in one case, to lengthen the vas by unraveling it from the epididymis. The result was a complete failure. The theory was based on the misconception that the vas deferens was too short.

5. SCHÜLLER'S OPERATION.—Early in the study of the pathology of undescended testis the presence of the open tunica vaginalis was regarded as a cause of non-descent. The abolition of this peritoneal prolongation was, therefore, considered imperative. As advised by Schüller, this was done by dividing the tunica at the internal inguinal ring, forming a new tunica vaginalis from the distal part and anchoring the testis to the bottom of the scrotum by sutures. This operation has in the writer's hands succeeded in a small number of cases; but only in those where the testis is already very close to the scrotum; in other words, in milder degrees of the affection. In more aggravated cases, however, when even the slightest tension upon the cord must be exerted, one of 2 accidents happens: either the testis tears loose from its anchorage in the scrotum and retracts to its original position, or, if the anchorage holds, the scrotum gives way and is invaginated and pulled up by the retracting testis.

In order to obviate this, the method has undergone numerous modifications.

(a) The fascial structures of the cord were sutured to the pillars of the external inguinal ring (Dowd, Kocher).

(b) The septum scroti was incised, and the undescended testis was sutured to its fellow of the opposite side.

(c) The testis was anchored to the bottom of the scrotum by sutures passed through the latter and tied over an external pledget of gauze.

(d) Lanz's operation (37). Sutures were passed through the testis; these sutures were then passed through the scrotum, left long, and fastened to a wire cage, to the thigh, or, even to the big toe; the principle being that the continuous traction would so lengthen the cord that, upon removal of the sutures, the testis would stay within the scrotum. Ingenious as this idea appears, I have seen 2 recurrences after this operation.

(e) A small incision is made in the bottom of the scrotum, through which the testis is extruded; the incision is closed snugly, leaving the testis outside, the idea being to leave it there until adhesions have formed, whereupon the incision is reopened and the testis replaced. The objections to this method are: first, the dangers of infection; second, the uncertainty of a good, or, better said, the certainty of a bad result.

(f) Starr (62) fastens the testis to a wire splint, which is fixed at one end to the pubic bone and at the other end to the scrotum.

(g) Keetley-Torek (31). This operation is divided into many steps, consisting in a great measure of very delicate manipulations and complicated sutures. A detailed description of the operation is not necessary, but essentially it consists of the following steps: The testis is liberated and the hernia corrected. An incision is then made in the bottom of the scrotum, through which the testis is extruded. At a properly selected place, an incision is then made upon the thigh, down to the fascia; the testis is fastened to this structure, and the 2 flaps of the scrotal incision are sutured to the 2 flaps of the incision upon the thigh. The principle of the operation consists in the belief that the long-continued fixation of the testis to the thigh lengthens the cord. At a second operation, from 3 months to a year later, the scrotum and testis are liberated from the thigh, and the testis is replaced within the scrotum.

Excluding the technical difficulties, which are minimized by the originators of the operation, the operation possesses a number of objections. The post-operative course is not a very pleasant one for the patients; they object to the continuous dragging upon the testis, and after the wounds have healed their gait is worse than awkward. They are troubled for a long time by a disagreeable eczema, especially in hot weather, due to the opposed skin surfaces. The danger of infection is not small, and, finally, the necessity of performing 2 operations is not to be regarded lightly.

6. BECK'S NECKTIE OPERATION (6) at best can hold the testis only outside of the external inguinal ring, and, therefore, cannot be considered curative.

7. KIRSCHNER'S OPERATION (32).—This is a very recent addition to the many operative procedures. A sort of a bell-shaped receptacle is made for the testicle from a piece of the fascia lata of the patient (autoplastic), which is passed through a subcutaneous tunnel and is fastened to the superficial perineal fascia.

8. BEVAN'S OPERATION (8).—After reading Bevan's original report, I was inclined to be sceptical, believing that the division of such important parts of the spermatic cord must surely result in gangrene of the testis. Bevan's report, however, was so reassuring that I determined to give the operation a trial. Since then I have never had occasion to regret my decision.

The rationale upon which Bevan's operation for undescended testis is based will be discussed in a subsequent section. The operation in detail, as I perform it, is as follows:

1. The cutaneous incision is like that for the radical cure of inguinal hernia.

2. The aponeurosis of the external oblique is split in the direction of its fibers. Retraction of the lower flap exposes Poupart's ligament.

3. The hernial sac is now isolated and freed from the spermatic cord. This step requires caution, because the sac is very thin, and the cord is spread out, fan-shaped, over the sac. It is advisable to begin the isolation of the sac at the neck. When this isolation is completed, the peritoneal cavity is closed, either by transfixion and ligation or by a purse-string suture. It is needless to add that, when the testis is intraperitoneal, it is essential first to open the sac and extract the testicle from the abdomen. I have never seen the occasionally described adhesions between the testis and the peritoneum, due, as some authors claim, to a fetal peritonitis, and which are supposed to prevent the descent of the organ.

The distal part of the sac can be dealt with in 3 different ways: (a) It may be cut off close to its attachment to the testis; (b) it may be cut off at some distance from the testis and a new tunica vaginalis constructed; (c) it may be everted and sutured, as in the Winkelmann operation for hydrocele. I have used all 3 methods, and while I have obtained equally good results with all, I prefer the first method because it saves time.

In isolating the sac there is one very important point to be observed. The liberation of the vas deferens from the sac must be carried out with exceeding care. The vas deferens should never be handled roughly, and should certainly never be pinched with forceps. The ultimate viability of the testis depends, as will be shown later, upon the small artery of the vas, a branch of one of the vesicals, and if this is injured or becomes thrombosed, there is a grave danger of subsequent necrosis of the testicle.

4. If the parts are now examined, there are seen the vas deferens, its vessels, and the spermatic vessels diverging as they enter the inguinal ring; the former going downward and inward, toward the bladder, the latter almost directly upward and slightly inward.

The cord is now gauged as to whether or not it will permit transplantation. In minor degrees of non-descent transplantation may be possible. If it is impossible to bring down the testis, traction upon the cord will readily show that the vessels and not the vas deferens become taut.

In some instances, freeing the vessels of all extrinsic fascial structures, by teasing and occasional snips with the scissors, will enable one to bring the testicle down.

In very many, if not most cases of high inguinal or abdominal retention, not even this step suffices, and a still more radical step becomes necessary in order to permit of the transplantation of the testis into the scrotum without tension. The vas deferens is carefully held out of the way of injury, and the remainder of the component parts of the cord, i. e., the spermatic artery and veins, is completely divided between 2 ligatures, and the intervening piece resected. The moment this has been accomplished, the testis can be brought down with ease.

If there is still not sufficient leeway, or the vas is still taut when the testis is brought down to the level of the bottom of the scrotum, I recommend the following additional maneuver.

The testis, with its vas and epididymis, is held up to the light; in most cases, it will be seen that the vas deferens makes a long loop, extending in some cases even beyond the testis, and is connected to the epididymis only by a little loose cellular tissue. This loose cellular tissue is then cautiously divided with a pair of scissors, thereby unfolding the loop, and thus doubling the length of still available vas. It is true that the testis thus transplanted will be in a somewhat inverted position; but this circumstance is of no consequence. When this procedure is carried out, there is not the slightest difficulty in transplanting the testis, even beyond the desired position. It is unnecessary to add that during these manipulations the testis is protected from exposure by covering it with a hot compress.

5. The corresponding half of the scrotum is now stretched with the finger or dressing forceps for the accommodation of the testis. There is never any trouble with this step, no matter how small or how shrunken the scrotum may appear to be. Into the pocket thus formed the testicle is placed without any anchorage, and, in order to prevent any luxation, the neck of the scrotum is closed by an interrupted or circular suture.

6. The radical cure for the hernia is now proceeded with. I perform the Andrews operation without any transplantation of the vas. If the vas is transplanted, there occurs a certain amount of shortening, which it is preferable to avoid. In some instances I have performed the Fowler operation, in which the deep epigastric vessels are divided and the cord is transplanted downward and inward, thereby diminishing the arc of the spermatic cord. In one instance I attempted to gain length by liberating the deep epigastric vessels and slipping the testis behind these vessels before transplanting the organ into the scrotum. This proved to be an unnecessary and bothersome refinement.

The treatment of the accidental complications of a non-descended testis, such, for instance, as a twisting of the pedicle, depends upon the degree of viability of the organ. If the organ is deemed viable, it is untwisted, and transplantation may be proceeded with. If not viable, the testis is extirpated.

The treatment of maldescended testis depends upon the locality to which it had been misplaced. The cord is always of sufficient length to permit of transplantation after it has been properly exposed. Additional incisions are but rarely necessary; proper retraction will usually permit sufficient exposure.

Postoperative Course.—On the second or third day after operation, not infrequently more or less exudation occurs around the testis; the scrotum becomes greatly swollen and, occasionally, ecchymotic. Whether this is due to infarction or thrombosis, or to a diminished return of blood, cannot be definitely stated, inasmuch as I have never had occasion to re-open the wound. Under the application of a hot-water bag this exudation, however, quickly becomes absorbed. It therefore need occasion no alarm.

In other respects the postoperative course is that of a simple uncomplicated hernia.

Rationale of Bevan's Operation.—Bevan based his operation upon a close study of the blood supply of the testis, and upon the important discovery that the inability to bring the testis down into the scrotum is due to the shortness of the vessels of the cord.

For a long time it was assumed (Milflet, 40) that the spermatic artery is a terminal artery, and that it is the sole arterial supply of the testis. The more recent investigations of Griffiths (20) and Hill (25) have shown that this is an error, that the testis has an additional and, for our purposes, a very important blood supply, namely, the artery of the vas deferens, usually a branch of one of the vesical arteries.

In order to prove this satisfactorily from a physiological point of view, in 1910 I performed the following series of experiments on dogs. The spermatic vessels were divided and the testicles left in situ; the testicles were later removed at periods varying from 4 days to 3 weeks after operation. Dogs have an open tunica vaginalis, and it is very difficult, on account of the proximity of the rectum and urethra, to do the operation without incurring infection. The testes were *examined histologically; and in no instance did actual gangrene occur.* Microscopically some of the testes, especially those examined early, showed some necrosis in the interior of the testis; but around the periphery the alveoli were well preserved. It is possible that the testes were removed too soon after operation, not permitting sufficient time for regeneration to occur.

While these experiments are, therefore, not entirely conclusive in affording a proof of perfect preservation of the testicular tissue after ligation of the spermatic vessels, they do prove the important point that the testis does not of necessity become gangrenous. Another fact that must be kept in mind is that in dogs we are dealing with a normal, well-developed and large testis, while in the undescended human testis we are dealing with a small undeveloped organ. It is, therefore, justifiable to assume, with slight reserve, that the artery of the vas deferens, even if not sufficient to supply the highly differentiated and abundant tissue of the normal testis, may still be amply sufficient for an undescended testis. After all, when we consider that undescended testes, as shown by Haines, are in all probability non-spermatogenetic, the problem whether the alveoli of the testis are destroyed or not is a matter of small moment.

If further proof were wanting, the results of the Bevan operation speak for themselves. In no case in my experience did necrosis of the testicle occur, and the preservation of erectile power is, to a certain extent, proved by maintenance of perfect *potentia coeundi* in one adult case of bilateral undescended testis, upon which I have operated.

Results.—In cases in which the testis can be transplanted without complete division of the spermatic vessels the results are ideal.

In the worst cases, i. e. those in which the spermatic cord require division, the primary results leave nothing to be desired. The hernia certainly is cured; and in my experience gangrene of the testis did not occur in a single case. In a few cases, after the elapse of 2 or 3 years, there is noted a marked diminution in the size of the transplanted testis, which has become even smaller than it originally was. Whether the Sertoli cells and interstitial cells are preserved in such a testis remains a problem, inasmuch as I have never had the opportunity to remove one.

Despite this drawback, the advantages of the operation are, nevertheless, great.

7. INTERSTITIAL HERNIA

An interstitial hernia, broadly speaking, is one that in its development does not follow the course of the spermatic cord into the scrotum, but spreads out in the interstices or planes of the abdominal wall itself.

There are several such planes into which a hernia may become deflected.

1. Between the aponeurosis of the external oblique and subcutaneous fat.
2. Between the aponeurosis of the external oblique and the internal oblique.
3. Between the internal oblique and transversalis muscles.
4. Between the transversalis muscle and transversalis fascia.
5. Between the transversalis fascia and peritoneum.

Many of these herniæ are complicated by other anomalies in this region. A very frequent complication, for instance, is an undescended testis. Upon these findings the theory has been propounded that the undescended testis is the cause of this abnormal hernia. While this theory may apply to many cases, it is not true for all; first, because in a certain number we find no abnormality of the testis; and, second, because I myself and others have seen cases of this abnormality in the female sex. Others (Schmidt and Ehler, 59) have propounded the theory that the peculiar location of the hernia is due to an internal inguinal ring congenitally misplaced in an upward and outward direction. This theory they attempt to fortify by measuring the distance between the internal inguinal ring and the umbilicus and comparing it with the opposite side. I believe this theory untenable for the following reasons: first, the difficulty of making the correct measurements is almost insurmountable; second, the assumption that the displacement of the internal inguinal ring is congenital is difficult to explain. On the other hand, the displaçement is easily explained on the theory that it is acquired. That the internal inguinal ring can be displaced by a scrotal hernia is a well-known fact; in very large herniæ, for instance, the external and internal inguinal rings are opposite each other. In interstitial herniæ the dragging is in an upward direction; it is not surprising, therefore, that the internal inguinal ring is displaced upward and outward.

Goebel (18) gives an excellent résumé of the subject, to which those interested are referred.

In order to save repetition, it is well to mention here that many of these

herniæ are complicated by an ordinary oblique inguinal hernia that communicates, at the neck of the sac, with the interstitial hernia. We may differentiate, therefore, a "monolocular interstitial hernia" and a "bilocular interstitial hernia."

In most cases of bilocular interstitial hernia the 2 sacs communicate with each other at their necks, the communication, therefore, lying most frequently at the region of the internal inguinal ring. However, cases have been described in which the mouths of the 2 sacs were widely separated from each other. It is questionable whether these should be included within this category. It is preferable to classify them with the group of internal herniæ, more especially as they are most liable to be met with in the properitoneal form of interstitial hernia.

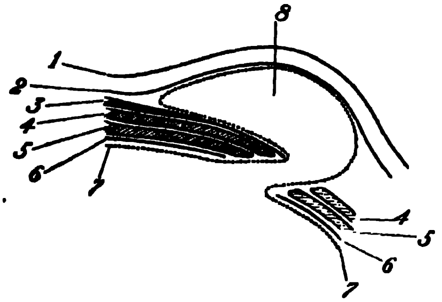

Fig. 22.—Diagrammatic Cross-section of an Inguinosuperficial Hernia, Lying on Top of the Aponeurosis of the External Oblique. 1, Skin; 2, superficial fascia; 3, external oblique; 4, internal oblique muscle; 5, transversalis muscle; 6, transversalis fascia; 7, peritoneum; 8, sac of inguinosuperficial hernia.

Some of the varieties of interstitial hernia are very difficult of recognition and are frequently recognized only when operated upon for an intestinal obstruction.

A hernia, instead of following the course of the spermatic cord into the scrotum, may spread out into any one of the spaces previously enumerated. Strictly speaking we may, therefore, have 5 varieties of interstitial hernia. Clinically, however, we differentiate only the following 3 varieties.

(a) Inguinosuperficial hernia (Küster).
(b) Interparietal hernia.
(c) Properitoneal hernia (Krönlein).

(a) Inguinosuperficial Hernia (Küster).—This variety was first ably described by Küster (36), and is, therefore, known as Küster's hernia.

In this variety the hernia passes through the internal inguinal ring, through the inguinal canal, and through the external inguinal ring; but at this point, instead of following the course of the spermatic cord, it is deflected upward and outward, so as to lie upon the aponeurosis of the external oblique (Fig. 22). While this is the most frequent deflection, cases have been described in which the hernia was deflected inward and even downward and outward upon the thigh. Inguinosuperficial hernia is very frequently accompanied by an undescended testis. It is furthermore the most frequent form of an interstitial hernia. When my paper upon this subject was published (42), only 17 cases had been recorded; since then both Coley and myself have seen this variety of hernia so frequently that it unquestionably occurs more often than the earlier statistics would lead us to infer.

An excellent idea of such a hernia can be obtained by picturing an oblique inguinal hernia dislocated subcutaneously at the external inguinal ring, out of the scrotum, upward and outward. Indeed some authors allege that this is the actual pathogenesis of this form of hernia.

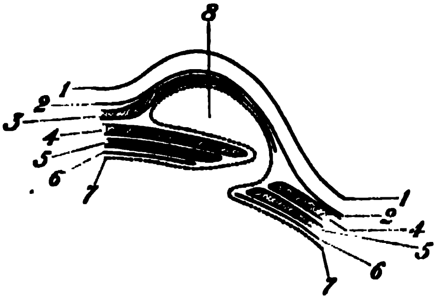

FIG. 23.—DIAGRAMMATIC CROSS-SECTION OF AN INTERPARIETAL HERNIA, LOCATED BETWEEN THE APONEUROSIS OF THE EXTERNAL OBLIQUE AND THE INTERNAL OBLIQUE. 1, Skin; 2, superficial fascia; 3, external oblique; 4, internal oblique; 5, transversalis muscle; 6, transversalis fascia; 7, peritoneum; 8, sac of interparietal hernia.

SURGICAL ANATOMY.—Excluding the less important structures, such as the intercolumnar, cremasteric and infundibuliform fasciæ, this hernia would, therefore, have the following coverings.

1. Skin, subcutaneous fat, and superficial fascia.
2. Peritoneum.

Behind the hernia we would have

1. Peritoneum again.
2. Aponeurosis of the external oblique.
3. The remaining structures of the abdominal wall.

The external inguinal ring is pulled upward and outward by the hernia, so that it lies directly opposite the internal inguinal ring.

The only interesting feature of these herniæ is their diagnosis, both before and during operation. The operation is the same as for an ordinary oblique inguinal hernia; the only step that is different is the necessary isolation of the sac from the anterior surface of the aponeurosis of the external oblique before the latter structure can be incised. If an undescended testis is present, it is treated in the manner already described.

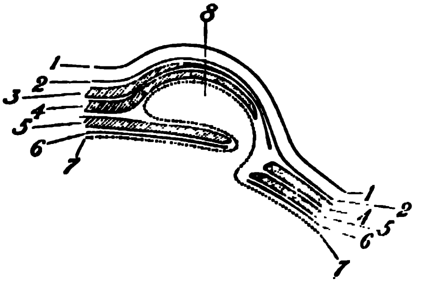

FIG. 24.—DIAGRAMMATIC CROSS-SECTION OF AN INTERPARIETAL HERNIA LOCATED BETWEEN THE INTERNAL OBLIQUE AND TRANSVERSALIS MUSCLES. 1, Skin; 2, superficial fascia; 3, external oblique; 4, internal oblique; 5, transversalis muscle; 6, transversalis fascia; 7, peritoneum; 8, sac of interparietal hernia.

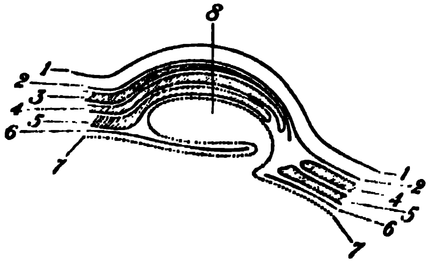

FIG. 25.—DIAGRAMMATIC CROSS-SECTION OF AN INTERPARIETAL HERNIA, LOCATED BETWEEN THE TRANSVERSALIS MUSCLE AND THE TRANSVERSALIS FASCIA. 1, Skin; 2, superficial fascia; 3, external oblique; 4, internal oblique; 5, transversalis muscle; 6, transversalis fascia; 7, peritoneum; 8, sac of interparietal hernia.

(b) Interparietal Hernia.—An interparietal hernia, in the narrow sense, is one that is deflected upward and outward between one or another of the fascial or muscular planes of the abdomen, after its escape from the internal inguinal ring.

The coverings and relations of such a hernia, therefore, vary according to the particular planes between which the hernia lies. The rarest form is that between the internal oblique and transversalis muscles; the most frequent is that between the aponeurosis of the external oblique and internal oblique muscles (Figs. 23, 24, 25).

The treatment also depends upon the variety; in the most frequent form, that which spreads out between the aponeurosis of the external oblique and internal oblique muscles, the aponeurosis may require a more liberal division than in the ordinary inguinal hernia. In the other interstitial forms, the internal oblique and transversalis muscle, or both, may require division, if proper retraction does not give sufficient exposure.

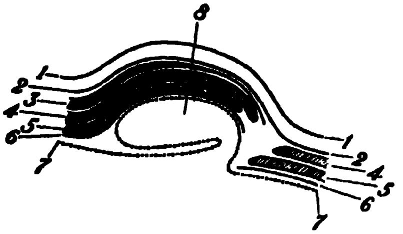

Fig. 26.—Diagrammatic Cross-section of a Properitoneal Hernia, Located Between the Transversalis Fascia and Peritoneum; Extending Upward from the Internal Inguinal Ring. 1, Skin; 2, superficial fascia; 3, external oblique; 4, internal oblique; 5, transversalis muscle; 6, transversalis fascia; 7, peritoneum; 8, sac of a properitoneal hernia.

(c) **Properitoneal Hernia.**—This variety of hernia was first described by Krönlein (34). In this form the hernia need not necessarily pass through the internal inguinal ring, unless the sac is bilocular. Instead of passing out through the internal inguinal ring, the hernia spreads out between the parietal peritoneum and transversalis fascia. It may, therefore, spread in any direction, upward, downward, outward, or toward the median line. I have seen 2 cases, both of which were directed downward into the pelvis, raising up the parietal peritoneum from the lateral pelvic wall (Figs. 26, 27, 28).

A description of the complicated surgical anatomy of this form of hernia would require more space than is at my command, but a sufficiently comprehensive picture may be obtained from the following description.

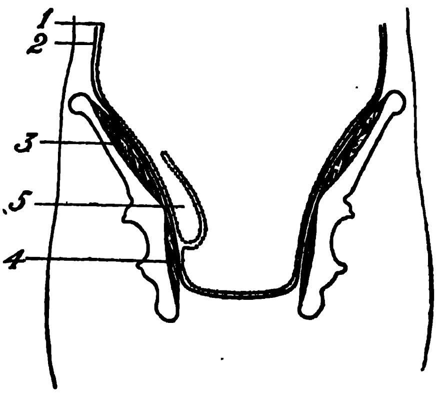

Fig. 27.—Diagrammatic Cross-section of a Properitoneal Hernia, Located Between the Transversalis Fascia and the Peritoneum; Extending Downward from the Internal Inguinal Ring, i. e., Into the Pelvis. 1, Peritoneum; 2, transversalis fascia; 3, psoas-iliacus; 4, obturator internus; 5, sac of a pelvic properitoneal hernia.

Let us imagine that the sac and contents of an ordinary scrotal inguinal hernia have been pushed back through the external inguinal ring, through the entire inguinal canal, and through the internal inguinal ring, into the abdomen, until the fundus of the sac is just beyond the internal inguinal ring. Suppose that we now again force the hernia out, but instead of finding its way back through the internal inguinal ring, the fundus of the sac is pushed downward into the pelvis, lifting the parietal peritoneum off the lateral pelvic wall, and finding a resting place between the pelvic peritoneum and pelvic fascia. In this manner a true properitoneal hernia develops.

Cases of this nature have been called "réduction en bloc." If the hernia is strangulated, it is self-evident that the hernia is still present, despite the superficial disappearance of the mass.

Judging from a comparatively small experience (cases of this nature are so rare that only a limited experience is possible) I doubt the existence of the phenomenon "réduction en bloc, or en masse." I believe that most cases presenting this symptom complex can be better explained upon the assumption that they are cases of properitoneal hernia. In their pathological anatomy and symptomatology they are identical; they are different only in their pathogenesis. One theory presupposes the existence of a preformed sac within the abdomen, and the other presupposes an inguinal sac that has been reduced into the abdomen. I am inclined to the first theory for the following reasons.

In a rather large experience with herniæ I have never found the isolation of the sac from the scrotal tissues an easy matter. In almost no instance is it possible to do this bluntly, even under the guidance of the eye, and recourse must be had to sharp dissection with knife or scissors. Credulity is, therefore, taxed to the utmost, when we are asked to believe that such isolation of the sac from the scrotum can be done by a sort of taxis.

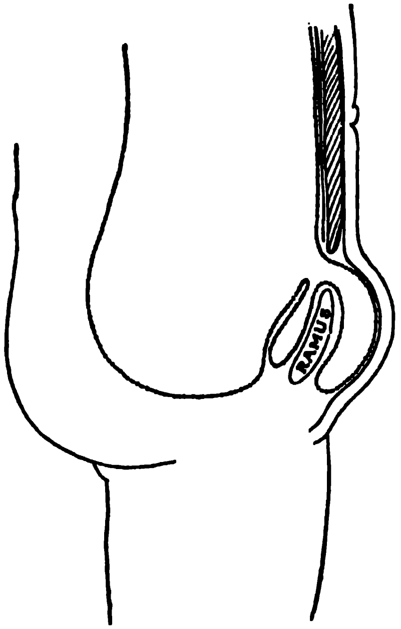

FIG. 28.—DIAGRAMMATIC CROSS-SECTION OF A BILOCULAR PROPERITONEAL HERNIA.

Furthermore, even were this possible, we should expect some evidence of trauma, such as bleeding or ecchymosis; such evidence, however, has never yet been recorded.

In one case diagnosed by me before operation not the slightest evidence of trauma was present.

In favorable cases the diagnosis can be made by rectal or vaginal palpation.

TREATMENT.—The operation for this condition differs from that for an ordinary hernia. The inguinal route gives an insufficient exposure and often renders the operation almost impossible. If the diagnosis has been made, it is best to proceed, as I have done in 2 cases, through an incision either directly in the median line of the abdomen or at the outer edge of the rectus.

With the patient in Trendelenburg's position, the constricting ring can be incised with the greatest of ease and without danger of injury to the gut; the hernial contents can then be reduced and dealt with according to indications. The hernial sac is everted and extirpated. If the hernia is of the bilocular variety, i. e. if there is an additional inguinal sac, a separate incision is needed.

Thus far the various subvarieties refer to abnormalities in the hernial sac only. We now come to abnormalities in the hernial contents.

The most frequent contents of an inguinal hernia are the omentum and the small intestine; but there is not an organ within the abdomen, with the exception of the pancreas and liver, that has not been found in an inguinal hernia.

II. ANOMALIES OF THE HERNIAL CONTENTS

1. Hernia of the Bladder

Owing to its proximity to the inguinal region, the bladder is quite frequently (1 to 3 per cent.) found in oblique inguinal hernia, either alone or accompanied by other viscera. For the same reason it is found even more frequently in direct than in indirect inguinal hernia.

It has already been noted (page 38) that if traction is exerted upon the sac of an inguinal hernia, the bladder is very frequently pulled out, and that care must be observed not to include it in the ligature. This dislocation is merely an artefact, and cannot be called a hernia of the bladder in the proper sense of the word. A hernia of the bladder is one in which the bladder forms part or the whole of the hernial contents. Eggenberger (13) and Felten (15) studied a large number of cases, and arrived at a similar conclusion.

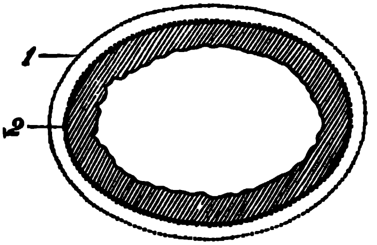

Fig. 29.—Diagrammatic Cross-section of an Intraperitoneal Hernia of the Bladder. 1, Sac of hernia; 2, prolapsed bladder, covered entirely by peritoneum.

Herniæ of the bladder give symptoms, mostly due to diminished capacity of the bladder, and can very frequently be diagnosticated before operation.

Varieties.—Anatomically we must remember that the bladder is covered by peritoneum only on its posterior surface and vertex; the following varieties of bladder hernia are, therefore, possible:

a. The intraperitoneal bladder hernia is one in which the entire prolapsed part of the bladder, usually the lateral and the posterior portion, is covered by peritoneum (Fig. 29).

b. The paraperitoneal bladder hernia is covered only in part by peritoneum; in other words, only that part of the bladder is prolapsed where the peritoneum is reflected from the bladder on to the parietal peritoneum (Fig. 30).

c. The extraperitoneal bladder hernia is one in which the prolapsed part is not covered by peritoneum (Fig. 31). The latter is seen most frequently in direct inguinal hernia; while the paraperitoneal variety is seen most frequently in oblique inguinal hernia. Least in frequency is the intraperitoneal bladder hernia.

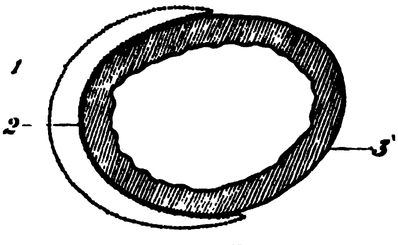

Fig. 30.—Diagrammatic Cross-section of a Paraperitoneal Hernia of the Bladder. 1, Sac of hernia; 2, bladder covered by peritoneum; 3, bladder not covered by peritoneum.

There is one further form of bladder hernia to which special attention should be called; namely, that in which the hernial contents consist of a "diverticulum of the bladder." It is very probable that pathologically these diverticula result from obstruction to the urinary outflow. As a result of straining, a hernia forms, into which this diverticulum is forced. Herniæ containing diverticula of the bladder are particularly important because injury is very likely to occur, inasmuch as recognition of the condition is difficult owing to the absence of muscular fibers.

Treatment.—That part of the bladder which is not covered by peritoneum is covered by properitoneal fat, i. e. the fatty tissue filling the space of Retzius. A peculiar lemon color is by some regarded as a characteristic of this fat; but I have not found this color sufficiently distinctive. It has already been noted (page 38) that the presence of fat in an inguinal hernia is almost pathognomonic of the proximity of the bladder; and that great caution should be exercised when fat is encountered during the process of isolating the sac.

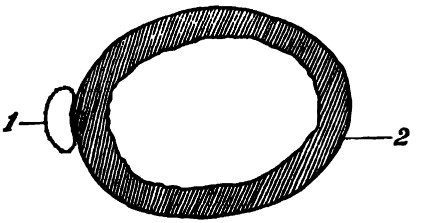

Fig. 31.—Diagrammatic Cross-section of an Extraperitoneal Hernia of the Bladder. 1, Sac of hernia; 2, prolapsed bladder, not covered by peritoneum.

If there is an intraperitoneal bladder hernia, the prolapsed part can be readily reduced like any other viscus.

When operating for a paraperitoneal bladder hernia, it is well to remember that part of the sac is formed by the area of the bladder which is covered by peritoneum. We may, therefore, isolate the sac in 2 different ways; some surgeons stop isolating the sac at the line of attachment of the peritoneum to the bladder and apply a ligature here. This is an error, because there remains a fairly large peritoneal diverticulum, which may be an excellent starting point for a recurrence. I have always proceeded in the following manner: Up to the point of the attachment of the peritoneum to the bladder, the operation proceeds along well-recognized lines; after this point is reached, the peritoneum is dissected up from the bladder, until that point is reached at which it appears that the application of a ligature will leave no peritoneal diverticulum behind. Great care is necessary in performing this step, so as not to injure the bladder;

a too deep dissection is immediately recognized by the appearance of the pale pink, muscular fibers of the bladder. The stripping off of the peritoneum from the bladder should be continued until the obliterated hypogastric artery, which can be readily recognized by its cord-like feel, is encountered.

As a matter of fact, the main point about herniæ of the bladder is the need to be constantly on the lookout for their presence.

In extraperitoneal hernia of the bladder there is no sac to be tied off; it is merely necessary to be sure that the case is not of the paraperitoneal form.

In either case the bladder is pushed back, and held back while the deep sutures are being tied.

It is advised by some, when the presence of the bladder in a hernia is suspected, to deliberately incise the bladder for exploration and to suture it. This is a procedure that is mentioned only to be condemned.

The treatment of accidental injuries of the bladder has already been discussed (page 38).

If a diverticulum of the bladder is encountered, and it does not appear advisable to push it back, resection may be indicated.

2. Hernia of the Ureter

The presence of the ureter in a hernia is an occurrence of extraordinary rarity. Reichel (57), Proera (56), and Hartwell (24) each describe one case. Femoral ureteral herniæ have also occasionally been described. I have seen 2 cases, one that was complicated by a hernia of the intestine, ovary, and uterus, and the second complicating a strangulated femoral Richter hernia.

If the ureter is not recognized, it may be injured in the course of the operation. Accidental injuries should be repaired by suture; in spite of the difficulties of the suture, wounds of the ureter heal kindly.

3. Hernia of the Ovary

Hernia of the ovary is not a great rarity, and is encountered when least expected; its possibility, therefore, must be constantly borne in mind. Hernia of the ovary occurs most commonly in very young infants and in women who have borne children; it is of extreme rarity between these 2 periods of life. The reason for this can be explained only in the following manner. The ovary is normally a pelvic organ and, therefore, is too distant from the internal inguinal ring to readily engage in it. In adults it comes in proximity to the internal inguinal ring only when lifted out of the pelvis by pregnancy or tumors of the uterus. In infants, on the other hand, the ovary comes into close proximity to the internal inguinal ring for a different reason. Before birth the ovary undergoes the same descent as the testis; in the course of this descent it comes to lie very close to the internal inguinal ring. If the descent is incomplete the ovary may remain in the neighborhood of the internal inguinal ring, and thus may engage within a hernial sac.

Ovarian herniæ are subject to certain accidents that may occur immediately upon the appearance of the hernia; one accident is a strangulation due to a torsion of its pedicle. In a paper upon this subject (47) I offer a plausible explanation of this accident. This is not, however, the place to discuss this topic. If careful attention is paid to clinical data, the diagnosis should be made in every case. The sudden appearance of a hernia in an infant, with symptoms of strangulation, associated with little or no evidence of prostration, arouses suspicion that the strangulation is not of the intestine. There are thus left only 2 organs that might be responsible, first, the omentum, and second, the ovary. The omentum is excluded at once, because it is never sufficiently developed in infants to be engaged in a hernia. By a process of exclusion, therefore, the only possible organ is the ovary. It is important to remember that strangulation is generally due to a torsion of the pedicle, and not to a tight ring. By this deductive method I have diagnosed 2 cases.

Very frequently the ovary in such a hernia is accompanied by the Fallopian tube. The latter is present in the form of a loop, or only its terminal end is involved.

When an ovarian hernia in adults is of long standing, the ovary may undergo cystic degeneration or other disease. I have seen a case of an ovarian cyst in an inguinosuperficial hernia. In small herniæ a part of the wall of the sac is formed by the unfolded broad ligament; the possible presence of the broad ligament must be borne in mind, because it may cause some difficulty in the treatment.

Treatment.—If the ovary is normal it is reduced; if diseased it should be extirpated.

Ovaries that have undergone torsion of the pedicle are untwisted, and if considered viable, are reduced; if non-viable, the ovary is extirpated.

If the broad ligament forms part of the wall of the sac, it must be carefully dissected away from the hernia and the neck of the sac ligated so as not to include some of the important blood-vessels coursing through the ligament.

4. HERNIA OF THE FALLOPIAN TUBE

Hernia of the Fallopian tube alone, i. e. without the presence of the ovary, is a rare condition. Two forms of this hernia may occur: one in which the end of the tube prolapses, and the second in which the tube prolapses in the form of a loop, so that both its beginning and termination are within the abdomen. Incidental unfolding of the broad ligament and its treatment have been discussed under the heading of ovarian hernia.

The prolapsed tube may be diseased in the form of a hydrosalpinx or pyosalpinx. Cases of tubal pregnancy in a hernial sac have also been reported.

5. Hernia of the Uterus

The uterus is occasionally found in an inguinal hernia. A number of cases have been reported in which the herniated uterus was gravid. Very rarely only one horn of a bifid uterus has been found *within the hernial sac.*

A hernia of the uterus may occur in 2 different forms. 1. The intraperitoneal, in which the entire prolapsed part is covered by peritoneum. 2. The paraperitoneal, in which that part of the uterus uncovered by peritoneum is contained within the hernia. We are accustomed to speak of the uterus as an organ covered entirely by peritoneum. Strictly speaking there is no organ completely invested by peritoneum, because that part through which the blood-vessels, etc., enter is always uncovered. This applies, therefore, to the lateral borders of the uterus to which the broad ligaments are attached. In some very large herniæ, the greater portion of the broad ligament of one side becomes unfolded and enters into the formation of the sac; in this way we may have a paraperitoneal form of uterine hernia.

I have seen a case of strangulated inguinal hernia in which not only the intestine and omentum, but also the tube, the ovary, the unfolded broad ligament, the ureter, the uterus, and its uterine artery were successively encountered during the operation.

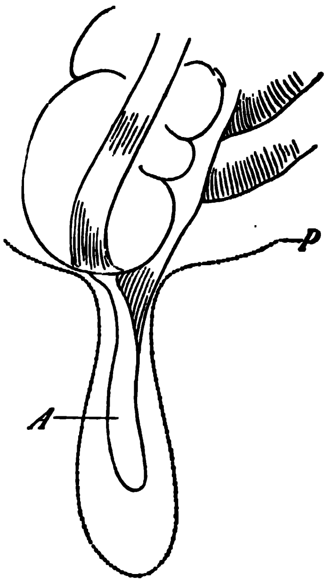

Fig. 32.—Intraperitoneal Hernia of Appendix.

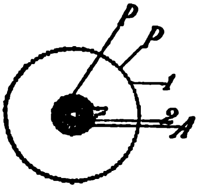

Fig. 33.—Diagrammatic Cross-section of an Intraperitoneal Hernia of the Appendix. 1, Sac of hernia; 2, cross-section of appendix and mesenteriolum, covered by peritoneum.

Treatment.—The only difficulty encountered in operations for uterine herniæ is the handling of the broad ligament. In freeing this structure, care should be taken not to injure its blood-vessels.

6. Hernia of the Appendix

The appendix, either alone or in conjunction with other viscera, is not a very rare finding in a hernia. It may be encountered in the following forms.

a. The appendix in toto, accompanied by its mesenteriolum, may be prolapsed in a hernia, so that it is practically entirely covered by peritoneum. In this form neither its reduction nor its removal should prove difficult. (See Figures 32 and 33.)

b. The mesenteriolum may become unfolded, so as to make up a part of the hernial sac. In this form the appendix appears as a retrohernial retroperitoneal organ (Figs. 34, 35). Reduction of such an appendix is practically an impossibility. In the removal of the organ care must be taken to securely ligate all the vessels of the mesenteriolum. After extirpation of the appendix there usually remains a rent in the posterior part of the sac; it is, therefore, preferable to sew up such a sac by a purse-string suture rather than to ligate it, because ligation of the sac leaves a raw surface within the peritoneal cavity.

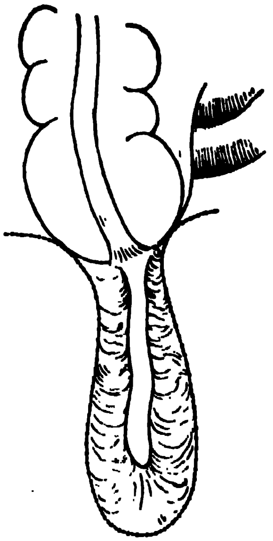

Fig. 34.—Sliding Hernia of Appendix. Note unfolding of mesenteriolum.

c. The free end of the appendix may become prolapsed (Fig. 36).

d. The appendix may prolapse in the form of a loop, so that both its beginning and its end remain within the peritoneal cavity (Fig. 37). This form is particularly prone to strangulation.

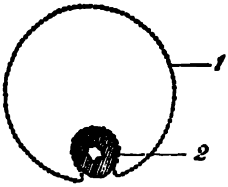

Fig. 35.—Diagrammatic Cross-section of Sliding Hernia of Appendix. 1, Sac of hernia; 2, cross-section of appendix, not covered entirely by peritoneum.

An appendiceal hernia may become strangulated. Again, the appendix in a hernia is as liable to become diseased as one situated normally. Differential diagnosis between the 2 is a matter of some difficulty; even at operation it is not easy to decide whether the appendix is merely acutely inflamed or strangulated. The only sure way to decide this point is the finding of a distinct strangulation furrow.

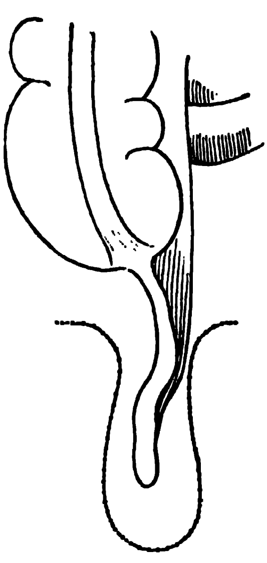

Fig. 36.—Hernia of Distal Portion of Appendix.

The treatment is evident.

Hernia Complicated by Appendicitis.—I have seen a number of such cases; these have certain puzzling features. The following clinical picture is the rule: The patient suffers from symptoms suggestive of acute appendicitis with the subsequent development of either a localized or a diffuse peritonitis. On physical examination, however, we find a very tense and painful hernial sac. We may be able to obtain the history of a preëxisting hernia. The presumption, therefore, is that the patient has a strangulated hernia, and that the development of the localized or diffuse peritonitis is due to the strangulation.

At operation we find the sac distended by a large amount of very foul pus, but otherwise empty. The diagnosis is now easy; we have before us an acute appendicitis, pus from which has leaked down and filled an open hernial sac. Search may be made for the appendix through the hernial incision; if found it is removed; drainage is instituted through the internal ring, and the radical cure of the hernia is postponed. The removal of the appendix through the internal inguinal ring is rarely possible. Were it even possible, it is preferable to remove the appendix and drain through a separate incision; in such an instance it is permissible to proceed immediately to the radical operation of the hernia. In spite of the bathing of the tissues with pus, such operations are frequently followed by primary union.

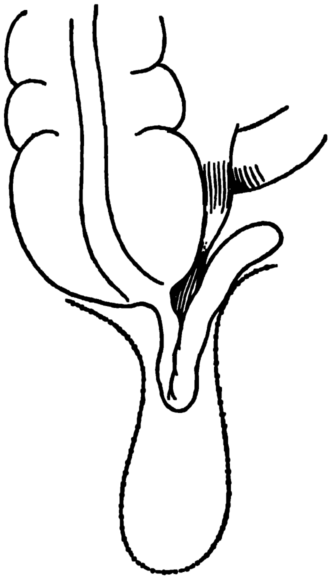

FIG. 37.—HERNIA OF APPENDIX IN LOOP FORM.

7. HERNIA OF THE LARGE INTESTINE

This subvariety of hernia is one of unusual interest. Although first described by Scarpa, it did not receive much attention until the French surgeons began to study the subject. The German articles are few and far between, although an excellent discussion of the subject has been published by Sprengel (61). In this country Weir (64) gave an excellent résumé of the subject, and published cases of his own.

Judging from personal experience, this form of hernia is of more frequent occurrence than one would be led to assume by the number of cases reported. This discrepancy can be accounted for in 2 ways: either the hernia has not excited sufficient interest in the operator, or (which in my opinion is more likely) the operator did not wish to be reminded of a rather unpleasant experience.

The operation for the radical cure of a hernia of the large intestine may prove to be of exceptional difficulty; it is important, therefore, that the surgeon bear the possibility of its presence constantly in mind. He must in addition be well acquainted with all the forms and possibilities of such a hernia, inasmuch as considerable, and often irreparable damage may be done by the uninitiated.

The 5 divisions of the large intestine, viz. cecum, ascending, transverse, and descending colons, and sigmoid flexure, all have their peculiarities when met with in a hernia. It is necessary, therefore, to discuss each division separately.

Sliding Hernia.—Before proceeding to the individual description of these subvarieties, it is necessary to call attention to a phenomenon peculiar to herniæ of certain portions of the large intestine.

This phenomenon has been called by the French *hernie par glissement*, or, translated into English, "sliding hernia."

It is difficult to give a short description of this phenomenon; but a clear mental picture of the hernia can be obtained in the following manner. Let us imagine, for instance, that the peritoneal attachments of the descending colon have become loosened from the subjacent structures, so that the colon, instead of being a fixed structure, now moves easily on its bed; let us then imagine that the peritoneum in the neighborhood of the internal inguinal ring is grasped and pulled in the direction of the scrotum. What will happen under these circumstances? First a hernial sac will be formed, and eventually the sigmoid flexure and descending colon will be pulled down. The successive steps of this process are illustrated in Figures 38, 39, 40, 41 and 42.

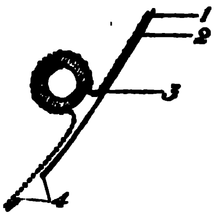

FIG. 38.—SLIDING HERNIA OF DESCENDING COLON BY "PULLING MECHANISM." First stage: 1, Peritoneum; 2, transversalis fascia; 3, descending colon; 4, internal inguinal ring.

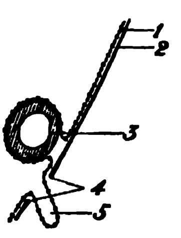

FIG. 39. — SLIDING HERNIA OF DESCENDING COLON BY "PULLING MECHANISM." Second stage: 1, Peritoneum; 2, transversalis fascia; 3, descending colon; 4, internal inguinal ring; 5, sac of hernia.

The sigmoid flexure, being covered on all sides by peritoneum, does not necessarily differ from a loop of small intestine, but the descending colon is usually covered only on 3 sides by peritoneum; it is evident, therefore, that after being pulled down, the descending colon itself will form part of the posterior surface of the sac. This is one variety of sliding hernia, and may be termed a "sliding hernia by pulling."

Let us now imagine the following: For the purpose of our experiment, the descending colon has again been loosened, as in the preceding example. Let us now suppose that pressure or force has been applied over the descending colon just above its junction with the sigmoid flexure. The direction of this force must first be backward, then downward and inward, toward the internal inguinal ring. What happens under these circumstances? First, the anterior wall of the descending colon is approximated to the posterior wall; the force continuing against the posterior wall, this segment of the descending colon is pushed nearer and nearer to the internal inguinal ring, until finally it is pushed out behind the peritoneum into the inguinal canal (Fig. 43).

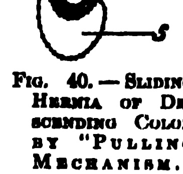

FIG. 40. — SLIDING HERNIA OF DESCENDING COLON BY "PULLING MECHANISM." Third stage: 1, Peritoneum; 2, transversalis fascia; 3, descending colon; 4, internal inguinal ring; 5, sac of hernia.

We now have a true hernia without any involvement of the peritoneum, i. e. a sacless hernia. In contradistinction to the first variety this may be termed a "sliding hernia by pushing."

Both of these herniæ occur with about equal frequency. There are certain differences between the two, with which it is well to be acquainted. Herniæ by pulling are usually very large; herniæ by pushing are very small. Herniæ by pulling usually have a very large sac; herniæ by pushing have no sac at all. In the herniæ by pulling, the nutrient vessels of the gut are usually pulled down with the gut; in the herniæ by pushing, the nutrient vessels need not necessarily be in the hernia.

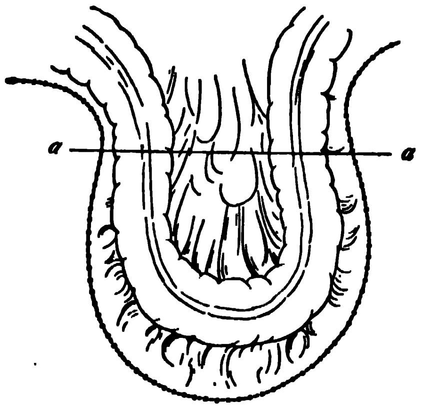

FIG. 41.—SLIDING HERNIA OF DESCENDING COLON BY "PULLING MECHANISM."

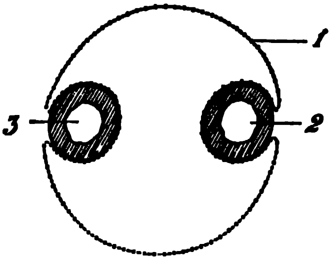

FIG. 42.—DIAGRAMMATIC CROSS-SECTION OF A SLIDING HERNIA OF THE DESCENDING COLON BY "PULLING MECHANISM." Section made at a—a in Figure 41: 1, Sac of hernia; 2, afferent loop of herniated colon; 3, efferent loop of herniated colon.

If this pathogenesis is borne in mind, it becomes evident that only those parts of the large intestine can be involved in a sliding hernia which are not covered on all sides by peritoneum. It is manifest, therefore, in spite of assertions to the contrary, that the ascending and descending colon are the only parts of the large intestine which can enter into the composition of a sliding hernia. Most authors speak of the sigmoid flexure as the sliding organ, but this is manifestly incorrect.

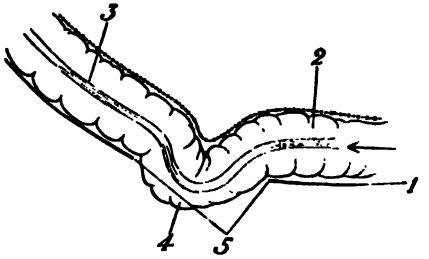

FIG. 43.—SLIDING HERNIA OF DESCENDING COLON BY "PUSHING MECHANISM;" SO-CALLED "SACLESS HERNIA." 1, Transversalis fascia; 2, descending colon; 3, sigmoid flexure; 4, herniated colon; 5, internal inguinal ring.

Before making a statement so radically different from the conventional view, it is necessary to define precisely what part of the large intestine is meant when we say "sigmoid flexure." Unfortunately even anatomists are not agreed, and call this part of the intestine by different names, such as sigmoid flexure, S. romanum, iliac colon, pelvic colon, S. iliac, etc. I prefer to adhere to the orthodox nomenclature, according to which the sigmoid flexure is that part of the large intestine which has throughout its entire extent a well-defined mesentery, the mesosigma, in contradistinction to the descending colon, which is covered on three sides only by peritoneum.

However, the distinction as to whether an organ is completely or incompletely invested by peritoneum is a very narrow one. Broadly speaking, there is no organ which is completely surrounded by peritoneum. All the organs are in fact extraperitoneal, being merely tucked to a greater or lesser extent into a closed peritoneal sac. It therefore also follows that almost every organ, under favorable conditions, may become the sliding part of a sliding hernia. Thus, for instance, we speak of the small intestine as having a complete peritoneal investment; yet in very large herniæ upon the right side, in which the cecum and ascending colon are pulled down, so much of the mesentery of the small intestine may become unfolded and enter into the formation of the huge sac that even the small intestine may appear as a sliding hernia. Similarly upon the left side, while we speak of the sigmoid flexure as having a complete peritoneal investment, the sac may be so large that the mesosigmoid becomes unfolded, and the sigmoid flexure itself may become the sliding part. But these are rare instances; I have never seen the sigmoid flexure as a sliding hernia, but have seen a case of a sliding hernia of the small intestine upon the right side which reached far below the knee. In general it may be said that the broader the uncovered area of a viscus, the greater is the likelihood of this viscus being found to be the sliding part of a sliding hernia.

On theoretical grounds we may, therefore, divide the abdominal organs, according to their likelihood of entering into the formation of a sliding hernia, into the following groups:

ALWAYS	NEVER	RARELY	LIKELY
Ureter	Ovary Stomach Liver Spleen Transverse colon Cecum Omentum	Sigmoid flexure Small intestine Uterus Fallopian tube	Ascending colon Descending colon Broad ligament Bladder Appendix

Finally I wish to state that, by the above description, I refer only to the sliding organ, which has nothing to do with the hernia. In other words, we may have combinations; thus, for instance, there is nothing to prevent the ovary from being in a sliding hernia of the descending colon; in such a hernia the ovary is merely an accidental inhabitant of the hernia, but only the descending colon is the sliding part.

Assuming the correctness of this pathogenesis of sliding hernia, it becomes self-evident that the term hernia of the large intestine, and sliding hernia, are by no means synonymous. This mistake is only too frequently made in medical literature.

All herniæ of the large intestine, whether sliding or not, have certain other peculiarities, according to the organ which has prolapsed.

Varieties of Herniæ of the Large Intestine.—A. HERNIA OF THE CECUM.—Anatomists have described several forms of cecum. For our purpose it is sufficient to say that the cecum is that part of the large intestine which lies below the ileocecal valve. Its blood supply comes from above and from the median area of the abdomen; it is, therefore, an organ which has a complete peritoneal investment. The cecum can, therefore, never be the sliding part of a sliding hernia. It is merely prolapsed into the hernial sac, and can always be reduced with the greatest of ease. *When, however, it is found in combination with sliding herniæ of the ascending colon and adjoining portions of the small intestine, then its reduction may prove difficult.* One form of such a hernia is particularly puzzling—so much so that the French have seen fit to give it a special name, *hernie par bascule.*

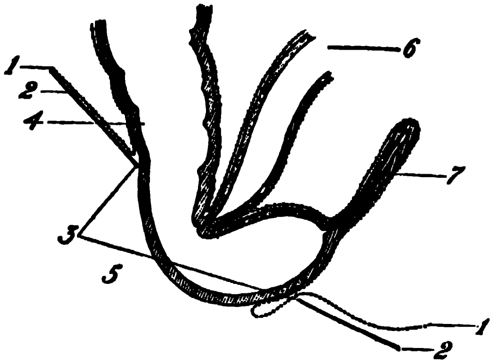

Fig. 44.—Diagrammatic Section of a "Hernie Par Bascule." 1, Parietal peritoneum; 2, transversalis fascia; 3, internal inguinal ring; 4, ascending colon; 5, cecum; 6, ileum; 7, appendix.

The pathogenesis of this hernia is as follows: Let us assume a very small sliding hernia of the posterior wall of the ascending colon at the point where this organ joins the cecum. During the progressive increase of the hernia, more and more of the adjoining portion of the cecum is being extruded, but a small part still remains within the peritoneal cavity (Fig. 44). We then have a small sliding hernia of the lowermost part of the posterior wall of the ascending colon, a small intrahernial part of the cecum, and a small intra-abdominal part of the cecum. It is as though the cecum were partly bent upon itself, like a hammock. This is the so-called *hernie par bascule.*

B. HERNIA OF THE ASCENDING COLON.—It has already been noted that the ascending colon occurs in an inguinal hernia only in the form of a sliding hernia (exception, of course, must be made for those isolated cases in which the ascending colon has a complete mesentery); furthermore that it may occur in 2 different forms; first, in large herniæ, the pathogenesis of which is explained by a "pulling" mechanism; in this case the ascending colon is frequently accompanied by other viscera in the vicinity of the internal inguinal ring, viz. the cecum, appendix, small intestine and omentum; and second, in small herniæ, the pathogenesis of which may be explained by a "pushing" mechanism; this second form may be entirely devoid of a sac, and may in consequence be very baffling. It is true there may be a very minute sac toward the mesial side of the gut, but this is to be expected from the dislocation of the intestine.

C. HERNIA OF THE TRANSVERSE COLON.—The transverse colon for practical purposes has a complete peritoneal investment; it is, therefore, never the sliding portion of a sliding hernia. In any event, it is a rare hernial content and then occurs only in herniæ of extreme size and when complicated by ptosis. Being completely invested by peritoneum, its reduction never causes any difficulty.

D. HERNIA OF THE DESCENDING COLON.—With slight modifications, the remarks on herniæ of the ascending colon apply equally to those of the descending colon.

E. HERNIA OF THE SIGMOID FLEXURE.—Most of the special articles on sliding hernia speak of herniæ of the sigmoid flexure as a type example of sliding hernia. The reasons why the sigmoid flexure, except under unusual conditions, cannot form the sliding part of a sliding hernia have already been given (page 74).

Treatment.—The treatment of uncomplicated herniæ of the cecum, transverse colon, and sigmoid flexure does not differ from that of any other simple form of inguinal hernia.

The treatment of sliding hernia, however, i. e. the treatment of herniæ of the ascending or descending colon, is an entirely different proposition. There is hardly any other operation that may tax the patience and technic of the best equipped surgeon to a greater degree.

A. SLIDING HERNIA BY A "PUSHING" MECHANISM.—These herniæ are usually of small size.

Exposure may be readily obtained through the usual hernia incision. A fairly typical description of the difficulties such an operation may present is the following. The first difficulty that the operator encounters is that, search as he may for a sac at the usual site of the sac, i. e. toward the inner side of the cord, no sac is found; again and again he may repeat this search, and again and again he will fail. At this point he begins to doubt even the diagnosis of hernia. Perhaps the patient now reacts slightly from the anesthetic and coughs or vomits; suddenly a distinct hernial bulging becomes evident, and the search begins all over again, with the same negative results. The patient again vomits or strains, and then it is noticed that the hernia does not come down on the inner side of the cord, but to the outer side and posteriorly. Even at this stage it is fortunate if one recognizes, by this sign, that a sacless sliding hernia has to be dealt with. The surgeon who fails to recognize what he is dealing with, sure only of the presence of a hernia, boldly incises what he believes to be the sac, meets with hemorrhage, the importance of which he does not appreciate, and, to his chagrin, finds that he has penetrated the lumen of the gut. This graphic description need not be considered overdrawn; it occurs frequently.

The most important step in the treatment of these herniæ is their recognition. They are so small that they can readily be pushed back, with a little blunt dissection, not into the peritoneal cavity, but into the retroperitoneal space. It is not even necessary to open the peritoneum; at most the peritoneum at the inner side of the internal

inguinal ring may be incised in order to verify the correctness of the diagnosis; this small incision can be immediately closed by a purse-string suture.

Deep sutures are passed, care being taken that the gut is held replaced during the process of tying.

B. SLIDING HERNIA BY A "PULLING" MECHANISM.—In contradistinction to the preceding variety, these herniæ are usually of large size.

A picture of the operation for such a hernia is often as follows: Being of large size, the sac is easily found and incised. Various hernial contents are found, and most of them are readily replaced; but there still remains a piece of intestine which resists all efforts at reduction. There is more pulling, more pushing, and more violence, but this piece of intestine refuses to budge. The sac is then incised more widely, and it is fortunate for both the patient and surgeon, if the latter even now recognizes that he is dealing with a sliding hernia of the large intestine. The operator who fails in this recognition regards the intestine as adherent and proceeds to liberate it; he divides the peritoneum on one or the other side of the intestine; soon considerable hemorrhage is encountered, which is interpreted as coming from vascular adhesions. What has really happened is that the vascular supply of the prolapsed gut is being cut off. After sufficient gut is liberated, a finger is passed into the peritoneal cavity; the continuation of the gut is felt, and is interpreted as the continuation of the adhesions. If the liberation of the intestine is further proceeded with, the lumen of the gut may be entered. The gut is finally reduced in a slipshod manner, and the sac tied off in an equally slipshod way. If only a small piece of the intestine has been thus deprived of its arterial supply, the anastomotic circulation may be sufficient to restore vitality; if, however, a large piece of the gut has thus been deprived of its arterial supply, or if the ligatures have been placed too close to the gut, beyond the last anastomotic arches, gangrene may result and the patient may die from a perforative peritonitis.

The surgeon who knows proceeds differently. When he finds that there is difficulty in reducing the last piece of intestine, he incises the sac more liberally, inspects this piece of intestine, and finds here and there upon its surface small pieces of fat, which he recognizes as epiploic appendages; further inspection will also reveal to him, upon the surface of the gut, at least one longitudinal band; both points absolutely indicative of large intestine. He does not look upon it as an adherent loop of intestine, but correctly diagnoses it as a sliding hernia of the large intestine and proceeds to treat it as such in the following manner, first suggested by Hotchkiss (27) and amplified by Walton (63).

Assuming that the incision of the sac was properly made, in the center of its anterior surface, its liberation is proceeded with cautiously; first the spermatic cord is encountered and dissected away; the liberation proceeds further and further, and is quite easy, if it has been started in the proper line of cleavage, until the hernial sac and the herniated intestine, plus its blood-vessels, are lifted up from the posterior wall of the hernial space. None of the blood-vessels should be injured if this dissection is properly done. The sac is thus liberated on both sides, but far more freely on the outer side.

The intestine and sac are now held up perpendicularly, when it will be seen that on both sides of the intestine the sac drops down over the nutrient vessels; the sac is now fastened here and there by an interrupted stitch; when this is done it becomes clear that a sort of an artificial mesentery for the intestine has been constructed. If the liberation of the intestine and vessels has been properly done, there should be no further trouble in reducing the intestine. The remainder of the sac is now closed by a running suture, as a ligation is evidently impossible. The radical operation of the hernia is now proceeded with in the usual manner. Throughout the operation it must always be borne in mind that the vessels enter from the mesial side of the gut; particular care is, therefore, necessary not to injure them.

In one case I attempted the following procedure for the cure of a sliding hernia, after the diagnosis of a sliding hernia by the "pulling" mechanism had been established. The inguinal incision was temporarily packed with gauze. A separate abdominal incision was made; in the Trendelenburg position the colon was now pulled back into the abdomen and fastened to the posterior abdominal parietes by sufficient interrupted stitches of silk (colopexy). After closure of the abdominal incision the redundant part of the hernial sac was freed and extirpated, and the radical part of the operation finished in the usual manner. I have since learned that Lardonnois had previously suggested a similar procedure.

FEMORAL HERNIA

Every hernia that passes out of the abdomen on to the thigh, and underneath Poupart's ligament is a femoral hernia. There are several different varieties of femoral hernia.

SURGICAL ANATOMY

The following anatomical structures and landmarks are important in relation to the anatomy of femoral hernia.

1. The skin, subcutaneous fat, and superficial fascia (cribriform fascia).
2. The internal saphenous vein and the tributaries which it receives in this part of its course.
3. The fascia lata of the thigh.
4. Poupart's ligament and its reflections and continuations, viz. Gimbernat's and Cooper's ligament.
5. The transversalis fascia and its prolongations, the sheath of the femoral vessels.

6. *The femoral and external iliac vessels.*
7. *The muscles situated in Scarpa's triangle.*
8. *The peritoneum and properitoneal fat.*

1 and 2. Skin, Subcutaneous Fat, Superficial Fascia, and Superficial Vessels.—The skin of this part requires no special consideration. The superficial fascia of the thigh is a continuation of the general superficial fascia of the body. It is particularly well developed upon the anterior surface of the thigh; indeed, by careful dissection it can be split into 2 layers, superficial and deep. The superficial vessels of this part of the thigh, viz., the internal saphenous vein and its tributaries, the superficial epigastric, superficial external pudic, and superficial circumflex iliac, as well as the lymphatic glands and vessels of the groin, are situated between these 2 layers of the superficial fascia.

3. Fascia Lata of the Thigh.—The fascia lata of the thigh, while one continuous layer, is so peculiarly distributed that a brief description is difficult. It is described by anatomists as consisting of 2 distinct but continuous portions; of which the iliac portion passes in front of the femoral vessels, and the pubic portion, which passes behind the vessels. Thus there is formed an oval opening in this fascia that permits the passage of the internal saphenous vein to the somewhat deeper lying femoral vein. The external and slightly anterior margin of the saphenous opening is formed by the iliac portion of the fascia lata, and is called the falciform process; the internal and slightly posterior margin of the saphenous opening is formed by the pubic portion of the fascia lata.

The deep layer of the superficial fascia is intimately adherent to the margins of this saphenous opening; it is perforated not only by the internal saphenous vein, but also by other vessels and lymphatics, so that it has a sieve-like appearance, and on that account has received the name of "cribriform fascia." An ordinary femoral hernia passes through the saphenous opening, and therefore receives a covering from this fascia.

The cribriform fascia is densely adherent to the saphenous opening, so that ordinarily we cannot see the saphenous ring until the cribriform fascia has been artificially dissected away.

4. Poupart's Ligament and Its Reflections and Continuation, viz. Gimbernat's and Cooper's Ligament.—The iliac portion of the fascia lata is attached above to the entire length of Poupart's ligament.

Poupart's ligament has in part already been described in discussing inguinal hernia. In order to study it to the best advantage, it is preferable to split the aponeurosis of the external oblique, when retraction of the lower flap and elevation of the spermatic cord reveal Poupart's ligament throughout its entire extent. At its inner extremity, Poupart's ligament is attached to the spine of the pubis. From this point it is reflected downward and outward to be attached to the pectineal line; this reflected portion has received the name of Gimbernat's ligament. The postero-external apex of Gimbernat's

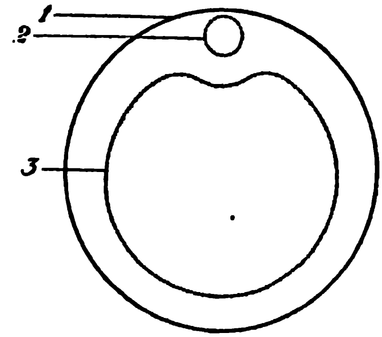

FIG. 45.

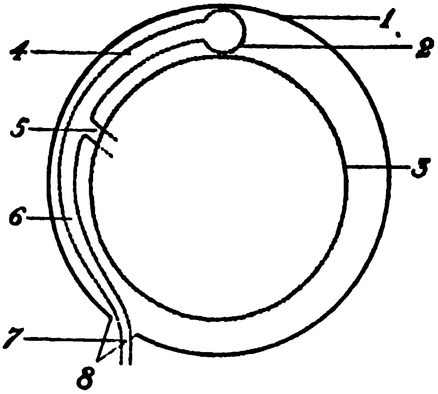

FIG. 46.

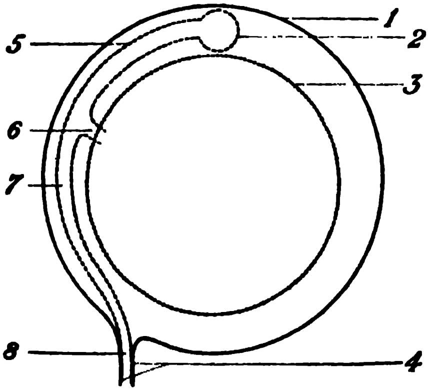

FIG. 47

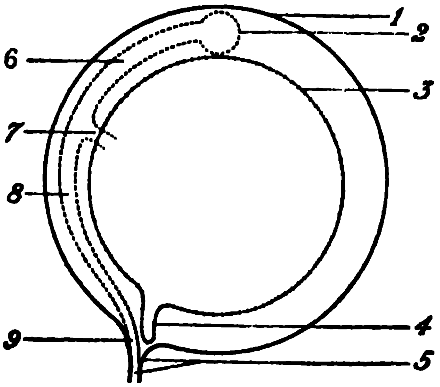

FIG. 48.

FIG. 45.—DIAGRAMMATIC CROSS-SECTION OF THE ABDOMEN, AT ANY LEVEL ABOVE THE BIFURCATION OF THE AORTA; SHOWING THE RELATIONS OF THE AORTA TO THE PERITONEUM AND TRANSVERSALIS FASCIA. 1, Transversalis fascia; 2, aorta; 3, peritoneum.

FIG. 46.—DIAGRAMMATIC SECTION OF THE ABDOMEN, SHOWING THE RELATIONS OF THE AORTA, COMMON, EXTERNAL AND INTERNAL ILIAC, AND FEMORAL ARTERIES TO THE PERITONEUM AND TRANSVERSALIS FASCIA. Note the hole in the transversalis fascia, through which the external iliac artery escapes to the thigh. 1, Transversalis fascia; 2, aorta; 3, peritoneum; 4, common iliac artery; 5, internal iliac artery; 6, external iliac artery; 7, femoral artery; 8, hole in the transversalis fascia.

FIG. 47.—DIAGRAMMATIC SECTION OF THE ABDOMEN, SHOWING THE RELATIONS OF THE AORTA, COMMON, EXTERNAL AND INTERNAL ILIAC, AND FEMORAL ARTERIES TO THE PERITONEUM AND TRANSVERSALIS FASCIA. Note the outward prolongation of the transversalis fascia upon the femoral artery, forming the so-called "sheath of the femoral vessels." 1, Transversalis fascia; 2, aorta; 3, peritoneum; 4, anterior and posterior prolongations and transversalis fascia, so-called "sheath of femoral vessels"; 5, common iliac artery; 6, internal iliac artery; 7, external iliac artery; 8, femoral artery.

FIG. 48.—DIAGRAM ILLUSTRATING AN INCIPIENT FEMORAL HERNIA. 1, Transversalis fascia; 2, aorta; 3, peritoneum; 4, sac of a femoral hernia; 5, sheath of femoral vessels; 6, common iliac artery; 7, internal iliac artery; 8, femoral artery.

ligament is continued as a strong wide band along the full length of the iliopectineal line; this band gives origin to the pectineus muscle, and is called Cooper's ligament.

5, 6, 7, and 8 of these structures will be described under the heading of pathogenesis.

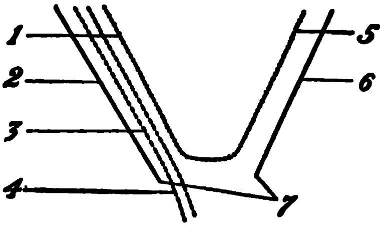

Fig. 49.—Diagrammatic Vertical Section Through the Femoral Region; Showing the Relations of the External Iliac and Femoral Artery to the Peritoneum and Transversalis Fascia. Note the hole in the transversalis fascia. 1, Peritoneum lining the false pelvis; 2, transversalis fascia lining the false pelvis; 3, external iliac artery; 4, femoral artery; 5, peritoneum lining anterior abdominal wall; 6, transversalis fascia lining anterior abdominal wall; 7, hole in the transversalis fascia.

PATHOGENESIS OF FEMORAL HERNIA

On page 3 I have set forth my conception of a hernia, and pointed out the great importance of the transversalis fascia in relation to hernia. Let us now see how this conception applies to the formation of a femoral hernia.

Certain self-evident facts need recalling; these are:

1. That the entire abdominal parietes are lined by peritoneum.

2. That external to the peritoneum there is everywhere a layer of a very dense fascia; that, though different portions have received different names, such as transversalis, iliac, pelvic, diaphragmatic, etc., the important point to remember is that this fascia is one continuous layer.

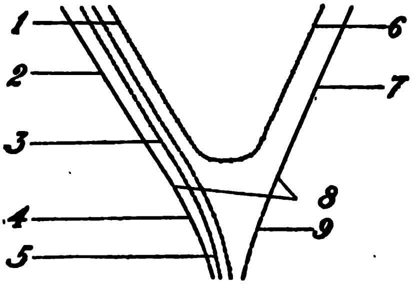

Fig. 50.—Diagrammatic Vertical Section Through the Femoral Region, Showing the Relations of the External Iliac and Femoral Artery to the Peritoneum and Transversalis Fascia. Note the hole in the transversalis fascia, and the anterior and posterior prolongations of this fascia, the so-called "sheath of the femoral vessels." 1, Peritoneum lining the false pelvis; 2, transversalis fascia lining the false pelvis; 3, external iliac artery; 4, posterior prolongation of transversalis fascia; 5, femoral artery; 6, peritoneum lining anterior abdominal wall; 7, transversalis fascia lining anterior abdominal wall; 8, hole in the transversalis fascia; 9, anterior prolongation of transversalis fascia.

3. That all the large vessels upon the posterior abdominal wall lie upon the transversalis fascia and are covered by the peritoneum, as shown in the accompanying diagram (Fig. 45).

The branches of the aorta, and particularly the femoral vessels, in passing out of the abdomen, pierce the transversalis fascia, as shown in the accompanying diagram (Fig. 46).

Nature, however, has put a nice finish to this hole, and instead of having a hole with a sharp edge, we find that the edges are turned outward, the fascia being continued downward for a certain distance, becoming thinner and thinner, and finally blending with the wall of the vessel itself. The accompanying diagram, therefore, represents the true condition (Fig. 47).

This prolongation of the transversalis fascia upon the femoral vessels has received the name of the "sheath of femoral vessels."

This prolongation of the transversalis fascia represents a weak spot, and it requires only a slight increase of the intra-abdominal pressure to make the peritoneum bulge into this part of the sheath, through the hole in the transversalis fascia. The lesion that results is a femoral hernia. A femoral hernia may, therefore, be represented diagrammatically as in Figure 48.

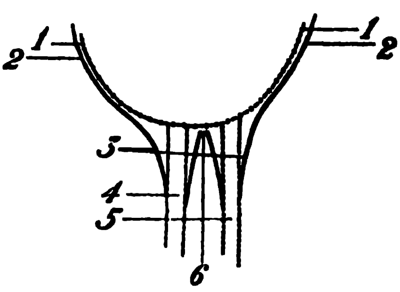

Fig. 51.—Diagram Illustrating Anterior View of the Femoral Region, Showing the Relations of the Femoral Artery and Vein to the Peritoneum and Transversalis Fascia, and the Outward Prolongations of the Latter Structures, so as to Form the So-called "Sheath of the Femoral Vessels." Note, also, the outward prolongation of the bridge of transversalis fascia between the two vessels, dividing the sheath into compartments. 1, Peritoneum; 2, transversalis fascia; 3, anterior and posterior prolongations of the transversalis fascia, so-called "sheath of the femoral vessels;" 4, femoral artery; 5, femoral vein; 6, compartment in the sheath of the femoral vessels.

The external iliac vessels leave the abdomen at that point at which the transversalis fascia, in its reflection over the anterior of the abdomen, makes an angle. This angle is at Poupart's ligament; the anterior part of the transversalis fascia ascends upon the abdominal wall and is called the transversalis fascia proper, while the posterior part lines the iliac fossa and is called iliac fascia. A diagrammatic cross-section is, therefore, represented by Figure 49.

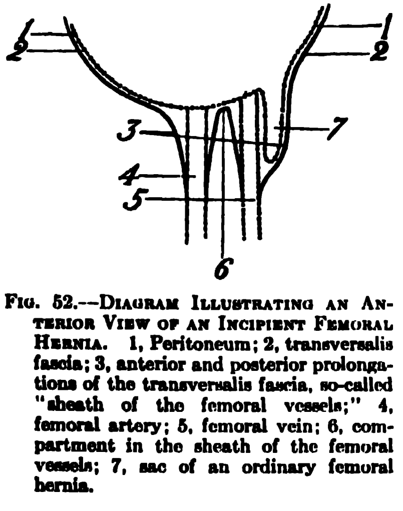

Fig. 52.—Diagram Illustrating an Anterior View of an Incipient Femoral Hernia. 1, Peritoneum; 2, transversalis fascia; 3, anterior and posterior prolongations of the transversalis fascia, so-called "sheath of the femoral vessels;" 4, femoral artery; 5, femoral vein; 6, compartment in the sheath of the femoral vessels; 7, sac of an ordinary femoral hernia.

To represent the continuation of these fasciæ we would have a diagrammatic illustration as in Figure 50, which would represent the state of affairs were only one vessel present. As a matter of fact, however, there are a vein and an artery, and these, while very close to each other, perforate the transversalis fascia through separate holes; the small bridge of intervening tissue also sends a prolongation down upon the vessels. The correct diagrammatic representation, therefore, as seen from in front, is as shown in Figure 51.

In order to allow ample room for the vessels in various positions of flexion and extension of the thigh, nature has provided that this sheath around the vessels be rather loose. It is particularly loose toward the mesial side of the femoral vein. In this large compartment there are a little fat, a few lymphatic vessels, and a small lymphatic gland, the gland of Rosenmüller. A diagrammatic representation of an ordinary femoral hernia, seen from in front, would, therefore, be as shown in Figure 52.

Every femoral hernia derives, in its descent, a covering from this sheath.

The peritoneum in this part of the abdomen is only part of the general peritoneum, and demands no detailed description.

It is important, however, to mention that, in contrast with oblique inguinal hernia, an abundant deposit of properitoneal fat exists in this part of the human anatomy. This deposit of properitoneal fat accounts for the fact that even empty femoral sacs cause a distinct bulging below Poupart's ligament, and that the sac is reducible only with some difficulty. After the sac of a femoral hernia has been out for a long time, or has become inflamed or injured, portions may be shut off by an adhesive inflammation; in such shut-off portions of the sac true cysts may form, making reduction of the sac even more difficult.

As in inguinal herniæ, the hole in the transversalis fascia corresponds to the internal ring.

We may, therefore, have the following coverings for an ordinary femoral hernia, as compared to the coverings of an oblique inguinal hernia.

INGUINAL	FEMORAL
Peritoneum	Peritoneum
(Rarely present)	Properitoneal fat
Infundibuliform fascia	Sheath of femoral vessels
Cremaster muscle and fascia	Absent
Intercolumnar fascia	Cribriform fascia
Superficial fascia	Superficial fascia
Skin and subcutaneous fat	Skin and subcutaneous fat

TREATMENT OF FEMORAL HERNIA

In perusing the literature of femoral and inguinal hernia, one fact becomes strikingly apparent. Recurrences are reported as very rare after operation for either variety; but whereas the operative methods for the relief of inguinal hernia are relatively few, the operations for the cure of femoral hernia are legion. A number of years ago I reviewed the literature of the subject, and, while the list was by no means complete, I found over 70 methods and modifications for the cure of femoral hernia. Since then, it is safe to assume, the number has materially increased. Let us recall a well-known and sound empiricism in medicine; when there are many remedies, it is a safe assumption that none is absolutely curative. This doctrine is only partly applicable to the methods for cure of femoral hernia. The plurality of operations in this instance is due to the many and intricate anatomical structures in relation to femoral hernia, rendering this a broad field for the exercise of ingenuity on the part of surgeons.

I have tried a number of these methods in succession, and while the results obtained were by no means unsatisfactory, the methods themselves were unsatisfactory, because they violated those fundamental principles which I have laid down as obligatory for the cure of hernia.

These principles are the following: 1. Firm closure of the peritoneal investment of the hernia at the point where it dilates into the general peritoneal cavity. By this is meant, that no opportunity shall be given for the formation of a peritoneal dimple, which can form the starting point for a recurrence. 2. As the hole in the transversalis fascia cannot be closed up completely, because a passage must be left open for the femoral vessels, it is, therefore, necessary to place a firm and permanent barrier of tissue in front of the peritoneum.

It would carry us far beyond the limits of the space allotted to consider successively all the methods that have been suggested. Inasmuch as they are all more or less only modifications of certain well-recognized basic methods, it will suffice if these methods are discussed briefly in groups. At the same time I will point out under each group how they violate the previously mentioned principles.

I. Ligation and Extirpation of the Sac

The first method limits itself to mere ligation and extirpation of the sac (Socin). While it cannot be denied that even by this, the simplest of all methods, an occasional radical cure can be obtained, its inefficacy is too apparent to warrant more extended consideration.

II. Incision in the Femoral Region

The second group of operations is performed through an incision in the femoral region. The direction of the incision, whether parallel with, or perpendicular to, Poupart's ligament, is of no importance. This is the most important group, and has the greatest number of followers. The underlying principle in these operations is theoretically correct, inasmuch as the aims are a high ligation of the peritoneum and a firm closure of the canal. Practically, however, the technical difficulties are such that these principles cannot be fulfilled with adequate security. The saphenous opening is situated at too great a distance from the internal opening of the sac to permit of a flush closure of the peritoneum, even when there are no adhesions, and when the sac is put upon the stretch to its utmost limits. Proof of this can be had by observing the behavior of the stump of the sac in such an operation. Instead of disappearing, as in operations for inguinal hernia, the stump remains within the femoral canal in the form of a pronounced projection. The result is that, in most instances, a smaller or larger dimple remains which may be the starting point of a recurrence. Furthermore, it is difficult, if not impossible, to effectively introduce the sutures for the purpose of closing the canal. Some of these operations (von Frey, Billroth, Czerny, Schede, Bottini, Guarneri, etc.) recommend the suture of Poupart's ligament to the fascia covering the pectineus muscle. These methods are evidently inefficient, because only the lower part of the femoral canal is closed; a fairly long portion of canal still remains, into which an occult hernia may descend.

Recognizing these objections, the advocates of the second method (Bassini, Berger, De Garmo, Coley, etc.) attempt to attain a higher closure of the femoral canal by suturing Poupart's ligament to Cooper's ligament and to the periosteum of the pubic bone. The various operations differ from one another only in the method of introducing the sutures; in principle they are alike. Theoretically this method is ideal, but technically it fails to accomplish the purpose for which it was designed. First, because, as has already been pointed out, it is difficult to obtain an adequately high ligation of the sac; and second, because, even with the best possible retraction of Poupart's ligament, it is extremely difficult to obtain with the suture a permanent hold of Cooper's ligament or of the periosteum of the bone. In the first place Cooper's ligament is very deeply placed; indeed, it is within the pelvis, and must be reached more or less blindly. In the second place, the angle between the under surface of Poupart's ligament and Cooper's ligament is too great to permit accurate adjustment. On many occasions I have convinced myself of the accuracy of this observation, both in operating on recurrences, and in numerous operations upon the cadaver.

The objection to the operation is that it does not do what it pretends to accomplish.

III. High Approximation of Poupart's Ligament to the Pubic Bone

It is recognized by many that the important part of any operation is an exact approximation of Poupart's ligament, high up, to the pubic bone. Many operations were, therefore, devised with this object in view. (It is taken for granted that the sac is eliminated in the usual manner; no further mention will therefore be made of this step.) Thus Roux nails Poupart's ligament to the pubic bone with a "U"-shaped metal tack. In a certain proportion of cases such a tack heals in situ; did this even occur regularly, it is quite probable that eventually the foreign body would loosen from its bed, become extruded, and allow the release of Poupart's ligament from its new attachment. In addition there is the disadvantage of having a metallic foreign body in the tissues, with its attendant complications. Nicoll bores holes in the pubic bone, through which he sutures Poupart's ligament to the pubic bone; while Cavazzani employs the obturator foramen to accomplish this purpose. It is questionable whether any of these operations will find many followers.

IV. Division of Poupart's Ligament

Recognizing the difficulty of a proper approximation of Poupart's ligament to the pubic bone, partial or total divisions of Poupart's ligament have been advised as a primary step (Fabricius, Delagnière). The very division of this important structure is a drawback to the operation, as it invites new avenues for the formation of a hernia.

V. Autoplastic Procedures

The autoplastic (fascial, muscular, periosteal, and osteal) operations (Salzer, Prokunin, de Garay, Mikulicz, Trendelenburg, Pöllya, etc.) have, no doubt, a place in the radical cure of some rare forms of femoral hernia, and in exceptional cases one might have recourse to one or the other.

VI. Heteroplastic Operations

The heteroplastic operations (Salzer, Witzel, etc.) have manifest disadvantages, and should not be considered unless help cannot be obtained otherwise.

VII. Incision Above Poupart's Ligament

Finally, we have the group in which the incision is made above Poupart's ligament. To my mind this is the ideal method of approach, as it permits of manipulations at that portion of the hernial canal where most benefit can be afforded.

This group can again be divided into 2 subdivisions. In the first group (Lotheisen, etc.) belong those operations that unite the internal oblique and transversalis muscles to Cooper's ligament. This group undoubtedly constitutes an excellent operation, but from anatomical dissections I have found that after its performance there is still an open space between the outer edge of the attached muscles and the point of entrance of the external iliac vein into the thigh; this space may be the avenue for the formation of another hernia. However, even with this drawback, the operation is an excellent one, and I have used it in all those cases in which, by force of circumstances (for instance in large strangulated femoral herniæ), we are compelled to divide Poupart's ligament so extensively that this ligament cannot be utilized in the subsequent plastic. In the second subdivision (Ruggi, Edebohls, Cushing, Silver, Moschcowitz, etc.) belong those operations that permit of a high ligature of the hernial sac and a firm closure of the internal femoral ring; in other words, these operations embody both principles that have already been laid down as fundamental.

As this is the operation which I (51) have used constantly during the past

10 years, it will be described at some length. Bardesceu (4), some 9 years after the writer published his method, describes a method practically identical.

The operation can be divided into the following steps:

1. **Skin Incision.**—For most cases a cutaneous incision, approximately 3 in. in length, but depending upon the adiposity of the individual, parallel with the fibers of the aponeurosis of the external oblique, and about 1 in. above Poupart's ligament, will be satisfactory; in exceptional instances, to be later explained, a short vertical incision may be added at the internal end (Fig. 53).

As in the operation for inguinal hernia, the superficial epigastric vessels must be caught and ligated.

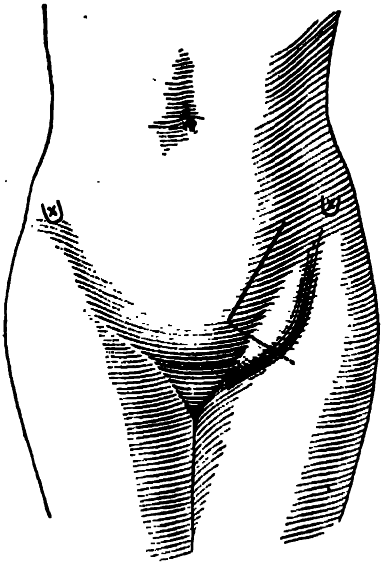

FIG. 53.—MOSCHCOWITZ'S OPERATION FOR THE RADICAL CURE OF FEMORAL HERNIA. Continuous line indicates the usual incision; dotted line indicates the occasionally necessary additional incision.

2. **Incision of the Aponeurosis.**—Retraction of the 2 sides of the incision exposes the aponeurosis of the external oblique and the external inguinal ring, covered by the intercolumnar fascia. The aponeurosis is now divided through the external inguinal ring for the full length of the incision (Fig. 54).

3. **Retraction of the Internal Oblique and Transversalis Muscles.**—Retraction of the lower flap exposes the round ligament (or spermatic cord) and Poupart's ligament, as in an operation for inguinal hernia; the posterior edge of the inner portion of Poupart's ligament forms a convenient guide to the location of the neck of the sac. Retraction of the upper flap exposes the conjoined tendon and the internal oblique and transversalis muscles. These 2 muscles, as well as the round ligament (spermatic cord) are retracted cephalad with a blunt hook (Fig. 55).

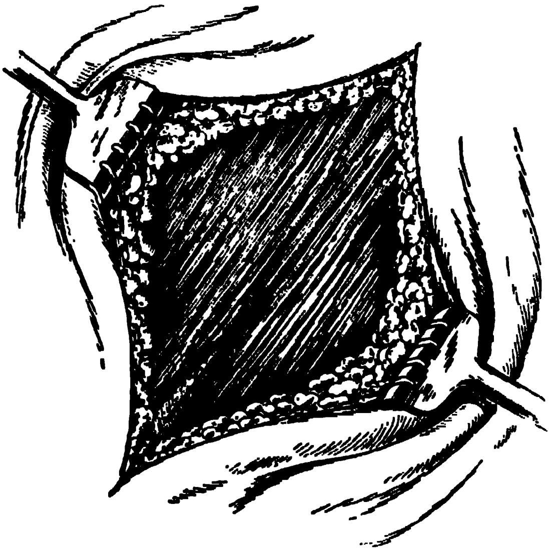

FIG. 54.—MOSCHCOWITZ'S OPERATION FOR THE RADICAL CURE OF FEMORAL HERNIA, SHOWING INCISION IN THE APONEUROSIS OF THE EXTERNAL OBLIQUE.

When this is done, there is exposed an irregular triangular space, which is divided into an outer and inner half by the deep epigastric vessels, which course upward and inward; the entire space is covered by the dense transversalis fascia.

4. **Incision of Transversalis Fascia.**—The transversalis fascia is now incised or nicked on the mesial side of the deep epigastric vessels, and either torn through or sharply divided from the epigastric vessels to near the pubic bone. The moment this is done, a peculiar phenomenon occurs; the properitoneal fat lying behind the transversalis fascia immediately bulges into the wound; this again proves the great strength of the transversalis fascia. The divided edges of the transversalis fascia are now retracted in order to expose the neck of the sac, which lies immediately behind it.

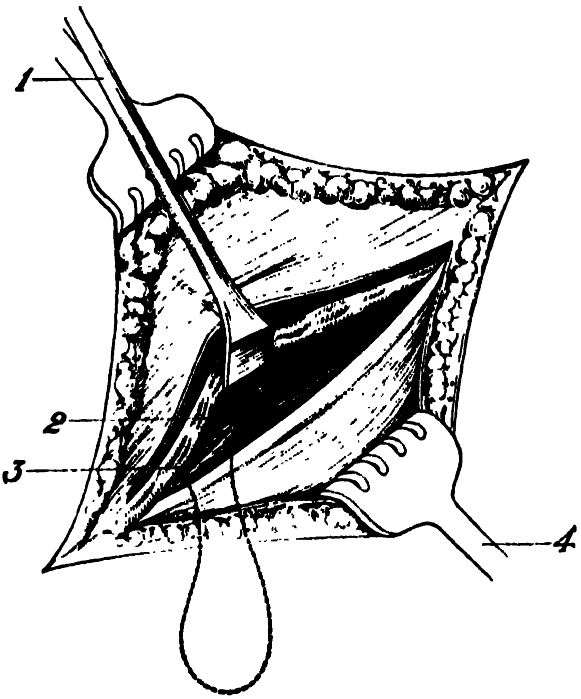

Fig. 55.—Moschcowitz's Operation for the Radical Cure of Femoral Hernia. 1, Retractor holding external oblique, internal oblique and transversalis muscles, and round ligament; 2, deep epigastric vessels; 3, incision of transversalis fascia covering Hesselbach's triangle; 4, retractor holding the aponeurosis of the external oblique, exposing Poupart's ligament.

5. **Exposure of the Sac.**—This step varies, according to whether the sac is empty or contains abdominal viscera.

If the sac is empty, it is simply grasped with a strong pair of forceps, and with steady traction is pulled up from the thigh underneath Poupart's ligament. As the sac gradually gives, the forceps are applied lower and lower, until finally the entire neck, body, and fundus appear in the incision (Fig. 56).

If this simple procedure is impossible, the thigh portion of the sac may first be dissected out, either by retracting the lower skin flap or through a short perpendicular incision continuous with the original incision. If the sac is too bulky, its distal portion may be cut away, and then the proximal part can be readily pulled through.

If, on the other hand, the sac contains viscera, it is wisest first to open the sac by an incision into its neck; the contents are now reduced and the sac dealt with in the manner described.

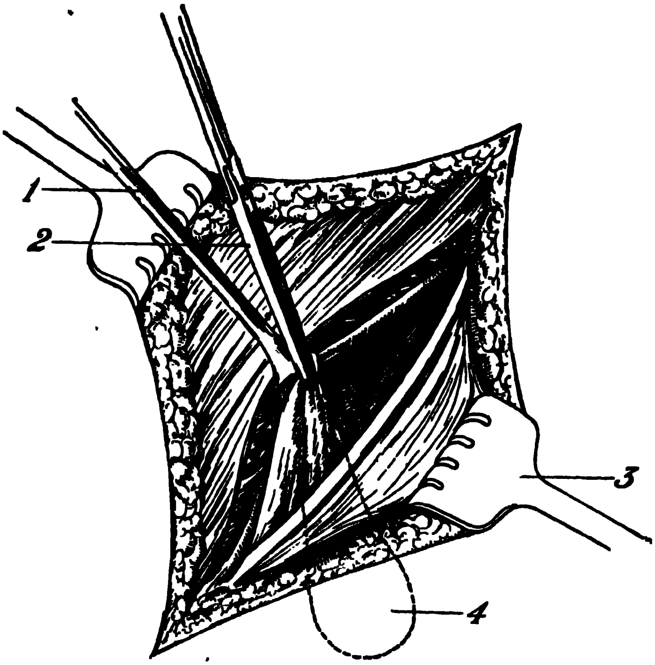

Fig. 56.—Moschcowitz's Operation for the Radical Cure of Femoral Hernia, Showing the Pulling Up of the Sac of the Femoral Hernia from Underneath Poupart's Ligament. 1, Retractor holding the external oblique, internal oblique and transversalis muscles, and round ligament; 2, forceps pulling up the sac of the femoral hernia (dotted outline) from underneath Poupart's ligament; 3, retractor holding the aponeurosis of the external oblique, exposing Poupart's ligament; 4, sac of femoral hernia.

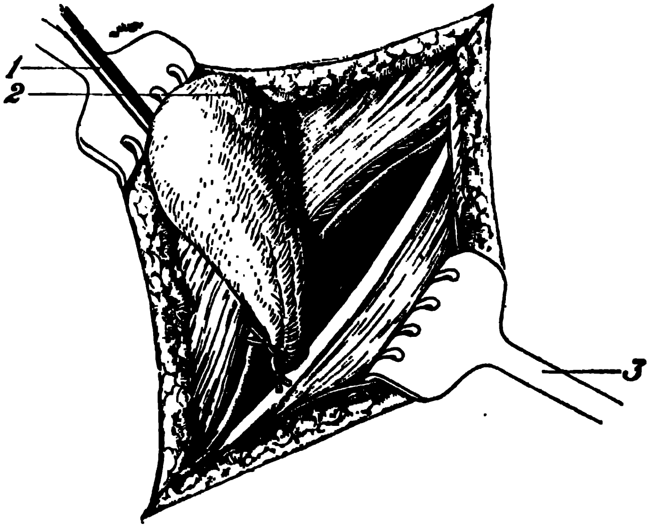

Fig. 57.—Moschcowitz's Operation for the Radical Cure of Femoral Hernia, Showing the Ligation and Extirpation of the Hernial Sac. 1, Retractor holding the aponeurosis of the external oblique, the internal oblique and transversalis muscles, and round ligament; 2, sac of femoral hernia, pulled up into the inguinal region, neck already ligated; 3, retractor holding the aponeurosis of the external oblique, exposing Poupart's ligament.

In dealing with a strangulated hernia, it is always best first to open the sac by an incision into its neck. In these cases an exudate into the hernial sac already infected by bacteria is frequently present. In order to prevent this infected fluid from running back into the peritoneal cavity when the strangulation is relieved, the peritoneal cavity is first protected by judiciously placed packings. The strangulation is now relieved; it is usually caused by the sharp edge of Poupart's ligament or by Gimbernat's ligament. In either case, it is best to relieve the strangulation by cutting or nicking Poupart's ligament. This can be readily done from without inward, and absolutely under the guidance of the eye, thereby avoiding injuries not only to the strangulated intestine, but also to an abnormal obturator artery. This vessel, as is well known, is frequently given off as a branch of the deep epigastric artery, and in its course encircles the field of operation, running around this part of Poupart's and Gimbernat's ligament. In such instances, if the incision of the strangulating ring is done blindly from below with a herniotome, the vessel is in danger of being injured. Even if injured, the obturator artery can be readily caught and ligated through the inguinal incision.

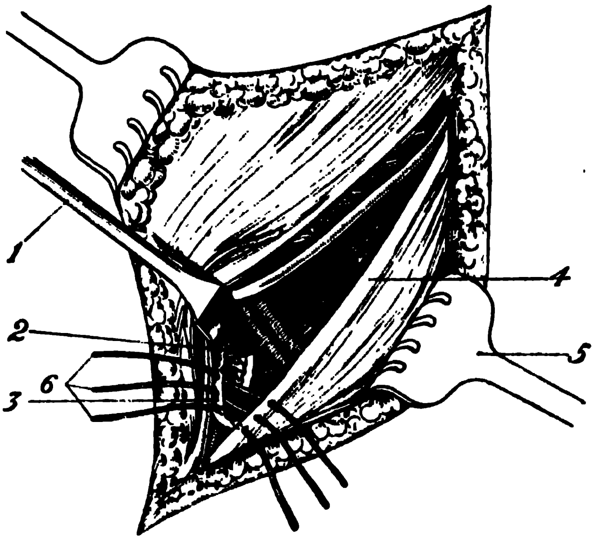

Fig. 58.—Moschcowitz's Operation for the Radical Cure of Femoral Hernia, Showing the Sutures Passed in Order to Close the Internal Femoral Ring. 1, Retractor holding the external oblique, internal oblique and transversalis muscles, and round ligament; 2, neck of sac ligated; 3, Cooper's ligament; 4, Poupart's ligament; 5, retractor holding the aponeurosis of the external oblique, exposing Poupart's ligament; 6, sutures passed between Cooper's and Poupart's ligaments.

If the parts are now examined, it will be seen that the femoral hernia has been converted, to all intents and purposes, into a direct inguinal hernia.

6. Isolation, Ligation, and Extirpation of the Hernial Sac (Fig. 57).—Attention has already been called to the great abundance of properitoneal fat in this region. This fat also suggests the proximity of the bladder; the isolation of the sac should, therefore, be done with caution, so that the bladder will not be caught in the ligature. The sac should be isolated high up, so that no dimple remains. The ligation is done either by transfixation or by a purse-string suture.

7. Closure of the Internal Femoral Ring.—The upper leaf of the aponeurosis of the external oblique, the internal oblique and transversalis muscles, round ligament (or spermatic cord) and the upper leaf of the transversalis fascia are now retracted with a blunt hook. A sponge brushes away the delicate cellular tissue in the bottom of the wound, and we have exposed before us, running upward, backward, and outward from the posterior margin of Gimbernat's ligament, a very strong ligamentous band, the ligament of Cooper. When this is done, the following anatomical structures present themselves: anteriorly the shelving edge of Poupart's ligament; externally the deep epigastric vessels, and at a slightly greater depth the external iliac vein; internally the spine of the pubis and Gimbernat's ligament; and posteriorly Cooper's ligament and the pectineus muscle. Above, under the retractor, are the peritoneum, upper leaf of the transversalis fascia, round ligament (or spermatic cord), internal oblique and transversalis muscles, and upper leaf of the aponeurosis of the external oblique. The internal femoral ring is thus perfectly exposed. With a strong, small full-curved needle, armed with No. 3 Pagenstecher thread, sutures are passed over the site of the femoral ring, between Cooper's ligament and the periosteum of the pubic bone, on the one side, and Poupart's ligament on the other (Fig. 58).

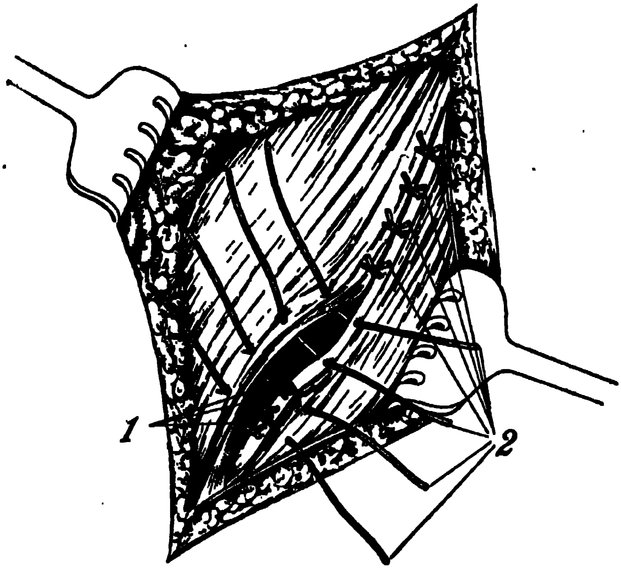

FIG. 59.—MOSCHCOWITZ'S OPERATION FOR THE RADICAL CURE OF FEMORAL HERNIA, BEING FINISHED BY THE ADDITION OF AN ANDREWS' OPERATION FOR INGUINAL HERNIA. 1, Sutures uniting Cooper's to Poupart's ligament; 2, sutures uniting the aponeurosis of the external oblique, the internal oblique and transversalis muscles to Poupart's ligament.

When the sutures are tied, Poupart's ligament will have been approximated to the pubic bone, thereby obliterating to a great measure the internal femoral ring; the ring cannot be completely obliterated, because room must be left for the passage of the external iliac and femoral veins. In a majority of instances 2 sutures will suffice to close the ring. The most external suture goes as near as possible to the external iliac vein, without constricting it; while the most internal suture also includes Gimbernat's ligament in its grasp.

8. **Closure of the Deep Wound.**—Thus far the operation resembles in most parts that of Ruggi; but, as already stated, the displacement of Poupart's ligament predisposes the patient to the development of an inguinal hernia. In order to obviate this danger, the divided transversalis fascia is first united

by suture, preferably by overlapping its edges, and then additional sutures are passed in the following manner. The round ligament (or spermatic cord), having been replaced in its normal position, Pagenstecher thread sutures, to the number of 5 or 6, are passed, which include the aponeurosis of the external oblique, the internal oblique and transversalis muscles, on the one hand, and Poupart's ligament, just anteriorly to the first series of sutures, on the other. Care must be taken to leave sufficient room at the inferior angle for the emergence of the round ligament (or spermatic cord). When these are tied, it will be seen that the deep wound has been closed by a typical Andrews' operation for inguinal hernia and the possibility of a formation of an inguinal hernia has been obviated (Fig. 59).

9. **Closure of the Superficial Wound.**—This step includes suturing of the aponeurosis of the external oblique, by an overlapping stitch (Fig. 60), and of the skin.

The wound is dressed in exactly the same manner as described for inguinal hernia.

The after-treatment does not differ from that of an ordinary inguinal hernia.

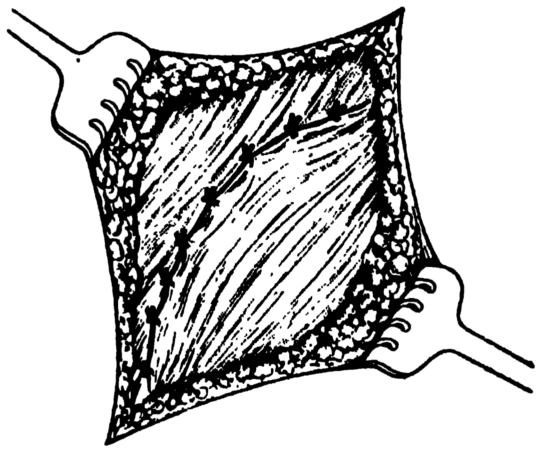

Fig. 60.—Moschcowitz's Operation for the Radical Cure of Femoral Hernia; Overlapping of the Aponeurosis of the External Oblique.

Dangers and Difficulties of the Operation.—1. In order to prevent the formation of a possible hematoma in the loose cellular tissue, hemostasis must be carefully attended to.

2. In isolating the sac, the proximity of the bladder must be constantly borne in mind.

3. The deep epigastric vessels may be injured in passing the 2 deep layers of sutures. Inasmuch as these vessels are fully exposed, injury must be the result of sheer carelessness.

4. The external iliac vein may be injured. It is necessary that the proximity of the vein be carefully borne in mind. If injury is feared, the vein may be protected by a properly placed blunt retractor.

5. The most external of the deep layer of sutures may be placed too close to the external iliac vein, and, when tied, the vessel may be compressed; this may lead to a thrombosis, or at least an annoying temporary edema of the lower extremity.

Results.—During the past ten years, I and my colleagues have performed many such operations; in not a single instance has a recurrence followed. In one of the earliest cases operated upon (this was done by one of the house surgeons of the hospital), a deep hematoma formed, necessitating a reopening of the second layer of deep sutures; this resulted in a direct inguinal hernia, which was successfully repaired.

Another great advantage of this operation is that it permits, at one sitting and through one incision, the radical cure of both an inguinal and femoral hernia. It is true that excellent results are obtained by other methods as well.

RARE FORMS OF FEMORAL HERNIA

I have seen but very few cases of abnormal femoral hernia. As compared to the classical type, these are so rare as to be regarded as surgical curiosities. But little space will, therefore, be devoted to these rare types.

1. **A prevascular femoral hernia** is one that descends in front of the femoral vessels within their sheath (Moschcowitz, 48).
2. **Hesselbach's hernia** passes to the outer side of the femoral artery, lying wholly in the lacuna muscularis.
3. **Cloquet's hernia** passes through the femoral canal to the inner side of the femoral vein; it does not, however, like an ordinary femoral hernia, escape from the saphenous opening, but spreads out upon the pectineus muscle, and is covered by the pubic portion of the fascia lata.
4. **Laugier's hernia** escapes through a defect in Gimbernat's ligament.
5. **Retrovascular Hernia.**—Some authors speak of a retrovascular hernia. I myself, however, deny even the possibility of such an occurrence.

UMBILICAL HERNIA

So many vessels or structures (the urachus, the 2 umbilical arteries, and the umbilical vein) have passed through the umbilicus during embryonic life, that it is difficult to decide at first glance which of these structures is to be blamed for making the requisite hole in the transversalis fascia, through which an umbilical hernia subsequently develops.

It is beyond the scope of this article to discuss in detail the development of the umbilicus. As its gross anatomy is, however, of the greatest importance for a proper understanding of the pathogenesis of umbilical hernia, it is necessary to devote a few lines to its description.

ANATOMICAL CONSIDERATIONS

The umbilical vessels are peculiar in 2 respects; first, there are 2 umbilical arteries and only 1 umbilical vein; second, the arteries and vein separate and run in different directions.

In the erect position, the large umbilical vein is superior, while the umbilical arteries and the urachus are inferior. Upon reaching the peritoneal side of the umbilicus these 4 structures immediately proceed in different directions. The umbilical vein runs backward and slightly to the right, into the fatty tissue of the ligamentum teres of the liver; the urachus descends perpendicularly from the inferior margin of the umbilicus to reach the vertex of the bladder; and finally the 2 umbilical arteries diverge and descend as obliterated hypogastric arteries to the lateral sides of the bladder (Fig. 61).

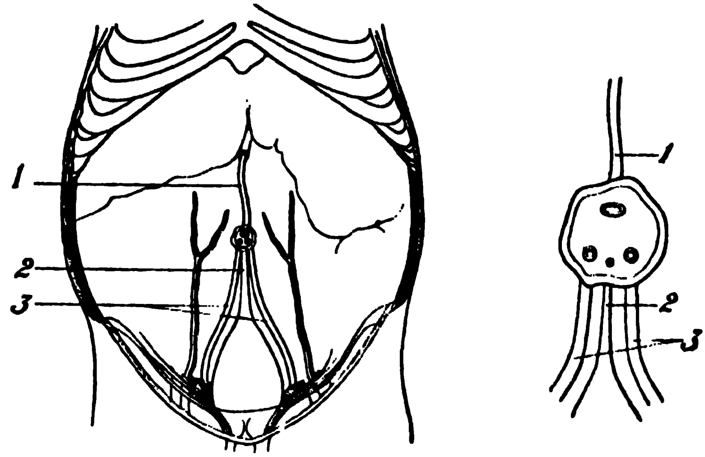

FIG. 61.—UMBILICUS OF THE NEW-BORN. (Waldeyer.) 1, Umbilical vein; 2, urachus; 3, umbilical arteries.

The gross anatomy of the umbilicus must also be understood in order to explain the most frequent findings in an umbilical hernia.

1. The skin is not continuous across the umbilicus. When the cord is ligated in the newborn, the part covered by the amnion necroses and is cast off, leaving a shallow ulcer behind, which becomes covered by the surrounding epithelium of the skin.

2. The superficial fascia coming from all sides becomes directly adherent to the cicatrix in the center of the umbilicus; not even a trace of subcutaneous fat is present to separate these two layers.

(The inner margins of the sheaths of the recti do not meet at the location of the umbilicus; the umbilicus may, therefore, be regarded as a deficiency in the linea alba.)

3. The transversalis fascia is perforated at 4 points in order to permit the passage of the 3 umbilical vessels and of the urachus. As already stated, these 4 openings are so distributed that the opening for the large umbilical vein is most superior, while the remaining 3 openings are most inferior and approximately on one level. That portion of the transversalis fascia situated between the 4 openings has received the name of "Richet's fascia." As in

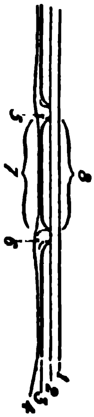

FIG. 62.—DIAGRAMMATIC CROSS-SECTION OF THE UMBILICUS IN A VERTICAL DIRECTION. 1, Skin; 2, superficial fascia; 3, transversalis fascia; 4, peritoneum; 5, umbilical vein; 6, urachus; 7, Richet's fascia; 8, umbilical cicatrix.

all other parts of the abdomen, when blood-vessels make their exit from the abdomen, the transversalis fascia is perforated by the vessel; furthermore, there is not merely a hole with sharply defined edges, but this fascia becomes everted and finally merges with the wall of the vessel itself. Now, in the completed umbilicus, these vessels are not continued beyond the niveau of the umbilicus, because they have sloughed off; therefore, the transversalis fascia ends at the umbilicus and joins the superficial fascia.

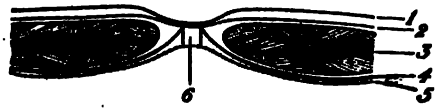

Fig. 63. — Diagrammatic Cross-section Through the Upper Part of the Umbilicus; in a Horizontal Direction. 1, Skin; 2, superficial fascia; 3, rectus abdominis; 4, transversalis fascia; 5, peritoneum; 6, umbilical vein.

4. Behind the transversalis fascia there is the continuous layer of peritoneum. Theoretically, therefore, a cross-section of the umbilicus varies at different levels and also upon a vertical or horizontal section.

In Figure 62 is shown diagrammatically a vertical section through the center of the umbilicus. Figure 63 shows diagrammatically a horizontal cross-section in the upper part of the umbilicus. Figure 64 shows diagrammatically a horizontal cross-section of the umbilicus at its center. Figure 65 shows a diagrammatic cross-section of the umbilicus at the lower part.

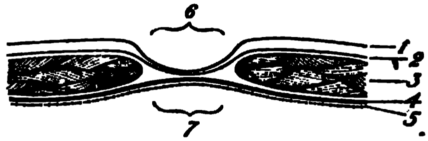

Fig. 64.—Diagrammatic Cross-section Through the Center of the Umbilicus, in a Horizontal Direction. 1, Skin; 2, superficial fascia; 3, rectus abdominis; 4, transversalis fascia; 5, peritoneum; 6, umbilical cicatrix; 7, Richet's fascia.

After the umbilicus has formed, the urachus and the 2 umbilical arteries are firmly united to the anterior abdominal wall; on this account there is very little space for the formation of a hernia between the margin of the umbilicus and these vessels. Indeed, hernia in this location is of exceptional rarity. The umbilical vein, however, enters directly backward into the fatty ligamentum teres of the liver, leaving an opening that is practically unprotected; this opening, so to speak, invites the formation of a hernia. This is actually what happens in an umbilical hernia; and careful examination will show that practically all umbilical herniæ pass through the hiatus in the transversalis fascia that has been made by the perforation of the umbilical vein. Even when there is no hernia present, we can frequently feel the sharp upper edge of the transversalis fascia at this point. Even a casual examination, particularly of the smaller umbilical herniæ, will show that the protrusion is through the upper part of the umbilicus.

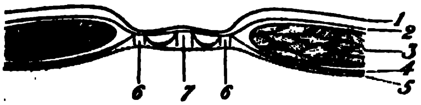

Fig. 65. — Diagrammatic Cross-section Through the Lower Part of the Umbilicus, in a Horizontal Direction. 1, Skin; 2, superficial fascia; 3, rectus abdominis; 4, transversalis fascia; 5, peritoneum; 6, umbilical arteries; 7, urachus.

This point also explains a very peculiar finding in most, if not all, umbilical herniæ, namely, that, despite a hernial protrusion, there is present at the same time an umbilical depression (Fig. 67).

This proves that an umbilical hernia is not a hernia through the umbilicus, but through one side of it.

An umbilical hernia can, therefore, be well represented in a vertical cross-section as in Figure 66.

It is furthermore apparent that an umbilical hernia has the following coverings.

1. Skin (no subcutaneous fat).
2. Superficial fascia.
3. Very much attenuated transversalis fascia.
4. Peritoneum.

Practically, however, these 4 layers are blended together.

Several different varieties of umbilical hernia are described, but both on theoretical and practical grounds these varieties are identical. Above all, there is no reason whatever to make a distinction between umbilical hernia in children and in adults. Both anatomically and pathologically they are certainly the same. It is true that an umbilical hernia in children is more amenable to non-operative treatment (it frequently disappears even by itself) than one in adults; but this is hardly a sufficient basis upon which to make a special classification.

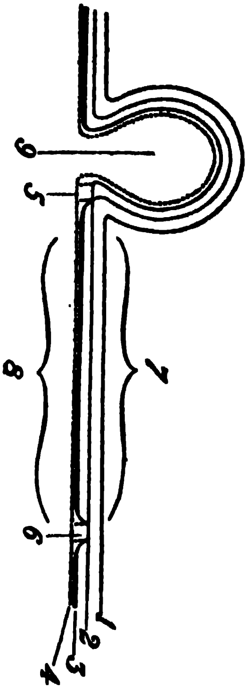

FIG. 66. — DIAGRAMMATIC CROSS-SECTION OF AN UMBILICAL HERNIA IN A VERTICAL DIRECTION. 1, Skin; 2, superficial fascia; 3, transversalis fascia; 4, peritoneum; 5, umbilical vein; 6, urachus; 7, umbilical cicatrix; 8, Richet's fascia; 9, umbilical hernia.

TREATMENT OF UMBILICAL HERNIA

In very young children and nurslings small herniæ are often met with which disappear spontaneously as the two recti muscles develop. It is possible that this cure is only an apparent one; it is plausible, also, that an umbilical hernia in adult life is only a reappearance of one that existed during early infancy.

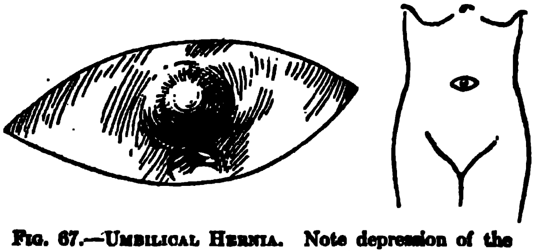

FIG. 67.—UMBILICAL HERNIA. Note depression of the umbilicus below the hernia.

Operation of small herniæ in infants is practically never indicated. Furthermore, we can assist nature in the cure by keeping the hernial sac always empty. Trusses of various kinds have been invented for this purpose, but these have no advantage over the simple procedure about to be described.

This consists in the firm application of a strip of adhesive plaster after infolding the umbilicus. The adhesive strip is changed after each bath, and at each sitting a new strip is applied at a slightly different angle, so as not to irritate the skin. The prophylaxis and treatment of diseases that cause an increase in the intra-abdominal pressure are also indicated. When the hernia is a large one, and the child has reached a suitable age, the operation about to be described is indicated.

In children there is usually present only a single sac, and the hernia as a rule is perfectly reducible. In adults, however, complications may arise, either from the pressure of trusses or from mild degrees of strangulation or other traumata. A mild intraperitoneal inflammation ensues, causing adhesions not only between apposed surfaces of the sac, but also between the contents themselves. Such herniæ are frequently irreducible; furthermore, sacculations and diverticulations of the sac are formed, which render the reduction of the contents difficult, even at operation. The sacculations and adhesions also favor strangulation, which in turn increases the inflammatory process; in this way a vicious circle is established.

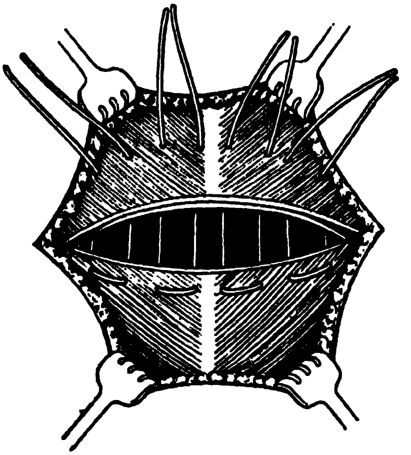

FIG. 68.—MAYO OPERATION FOR UMBILICAL HERNIA. Mattress sutures drawing the lower flap underneath the upper flap.

Umbilical herniæ in adults occasionally attain an enormous size, adding to the gravity of an operation.

The value of truss treatment in adults is practically nil.

The radical treatment of umbilical hernia has undergone as many vicissitudes as that for inguinal hernia. There are, however, certain fundamental principles that apply to all operations for umbilical hernia.

General Measures in Operations for Umbilical Hernia.—The incision into the hernia is to be made with great care. The thinness and absence of structures upon the apex of the hernia have already been pointed out and, if one is too bold, an injury of the hernial contents is not an unlikely happening. After the sac has once been opened, the incision can be completed boldly.

The contents of an umbilical hernia are most frequently small intestine, omentum and transverse colon; occasionally the stomach. The contents must be freed from one another and from the hernial sac; all the septa and diverticula must be opened up; and adherent omentum must be separated or, if necessary, removed. Before suturing the hernial opening, the finger is swept around the ring in order to make sure that everything is free.

Methods of Operation.—The various operative procedures that have been proposed are the following:

1. Suture of the peritoneum and suture of the skin; that this method is insufficient is manifest.

2. Through-and-through suture of all the structures gives only slightly better results.

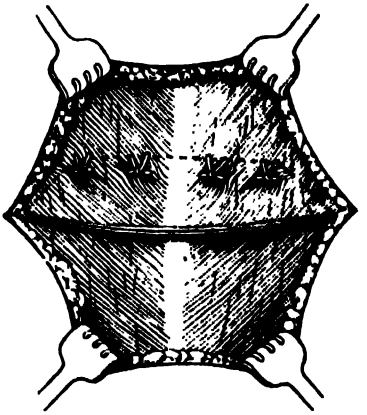

Fig. 69.—Mayo Operation for Umbilical Hernia. Mattress sutures tied; lower flap drawn underneath the upper flap.

3. Omphalectomy, i. e. excision of the umbilicus, followed by incision of the sheaths of the 2 recti, with subsequent suture in layers, gives somewhat better results, yet not sufficiently encouraging.

4. Graser's method (19) of suturing the different layers not in one line, but so that they meet at right angles, is an improvement over the foregoing.

5. Transposition of the 2 recti and various plastics upon the anterior sheaths of these muscles have had a transitory vogue.

Finally we come to the modern operations for umbilical hernia.

6. Either a longitudinal (Blake, 9) or a transverse (Mayo, 39) incision is made over the hernial protrusion. For reasons already mentioned, it is preferable to open the sac very early in the operation; the complete opening of the sac can then be done more boldly. The hernial contents are liberated from the sac and all septa are divided and the contents are reduced into the abdomen.

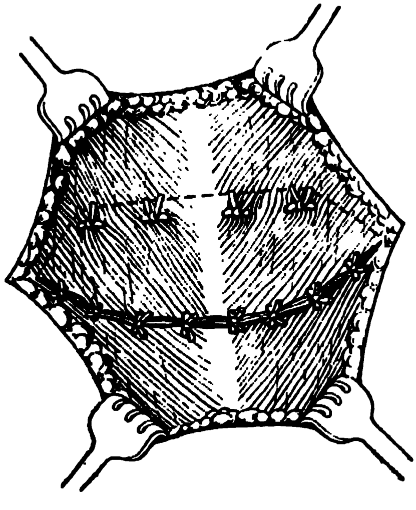

Fig. 70.—Mayo Operation for Umbilical Hernia. Overlapping of the two flaps.

Sutures of heavy chromicized catgut or strong Pagenstecher thread are now passed in the following manner. (Formerly it was deemed advisable to suture the peritoneum separately, but this is no longer found to be necessary.) Each stitch penetrates on one side the tissues at the incised margin; on the opposite side, at a distance of 1 or 2 inches from the margin. All sutures are inserted in the form of mattress stitches (Fig. 68). Several such sutures are passed, the number depending upon the size or the opening. When these sutures are tied, one flap is pulled underneath the other (Fig. 69). If necessary, intermediate sutures are passed. Finally, the superior layer is sutured with interrupted sutures over the inferior layer (Fig. 70). The skin is sutured in the usual manner.

Many of the afflicted patients are inordinately fat, and this fat, even if aseptic, exudes fat and serum for some time. It is, therefore, wise not to suture the external wound too tightly; in very stout patients even the introduction of a drainage tube is indicated.

If aseptic healing is obtained, the results are excellent. In theory each method has some advantage over the other, but in practice both give equally good results. The advocates of the transverse incision contend that, through their attachment to the sheaths of the recti, the lateral flat abdominal muscles tend to pull the vertical suture line apart; on the other hand, the transverse suture line is more likely to be pulled apart when the patient lies flat; and it is advised, by the advocates of the transverse incision, that the patient lie after the operation with the legs drawn up and shoulders elevated, so as to take off all tension. The vertical incision has perhaps the slight advantage that a coexisting diastasis of the recti can be corrected at the same time.

Dangers and Difficulties of Operative Treatment.—The operation in old cases of umbilical hernia is not a simple matter. Postoperative distention is a source of great discomfort to the patient and of considerable anxiety to the surgeon. The flabbiness of the patient and the distention tend greatly to embarrass the circulation, which, in its turn, favors the development of pneumonia. The number of infections is larger than in other forms of hernia. In spite of these drawbacks, the ultimate results are good.

HERNIA INTO THE UMBILICAL CORD

The name "hernia into the umbilical cord" is a misnomer. Under the generic term "hernia," we understand a protrusion of a hernial sac, consisting of peritoneum. As will be shown, no such sac is found in the malady under discussion. It is also customary to discuss so-called "herniæ into the umbilical cord" as a subdivision of umbilical hernia. This is also an error, for the following reasons. Hernia into the umbilical cord is really an antenatal disease; but the umbilicus is an anatomical landmark that is formed only post partum, and therefore has no relation to hernia into the umbilical cord. Furthermore, under the term "hernia" we assume a protrusion of a viscus out of the abdomen; but in a hernia into the umbilical cord the contents were probably never within the abdomen.

Pathogenesis.—At an early stage of embryonic life certain portions of the intestine are extra-abdominal; later these recede at the same time that the lateral abdominal walls meet in the median line and close over the opening, except at the attachment of the umbilical cord. Now in a hernia into the umbilical cord this recession of the abdominal contents does not take place, and the lateral abdominal walls do not meet each other.

Surgical Anatomy.—Herniæ into the umbilical cord vary greatly in size. The smaller varieties contain only a loop of the intestine; the larger ones contain not only a large part of the intestinal tract, but very frequently, also, the liver, spleen, etc.

At one point of the protrusion the umbilical cord is inserted. Around the base of the protrusion the cutaneous margin of the umbilicus is seen as an irregular wavy line.

The external coverings of such a hernia are the much thinned out and separated structures of the cord, i. e. a continuation of its amniotic layer. Internally, there is a very thin membrane which is continuous with the peritoneum, but not part of it, because it is entirely non-vascular. In the fresh state both membranes are transparent, so that the underlying viscera are recognizable with the greatest ease. Because the external and the internal membranes are non-vascular, a natural mummifying process sets in soon after birth and upon exposure to the air. These membranes soon become opaque, and infection occurs, resulting in a rapidly fatal peritonitis. If the hernia is very small and precautions are taken to prevent infection, adhesions may form, and thus spontaneous healing is possible. The cicatrization proceeds from the cutaneous margins of the umbilicus.

Treatment.—It is surprising how many cases can be saved by an immediate operation, despite the apparently enormous deformity.

The operation consists in a complete extirpation of both internal and external coverings of the hernial protrusion and subsequent suture of the defect, either in layers or by through-and-through sutures.

HERNIA OF THE LINEA ALBA

All herniæ that occur in the midline of the abdomen, with the exception of those that occur at the umbilicus, are grouped collectively under the name, "hernia of the linea alba." They are more frequent above the umbilicus than below. This is due to the greater width of the linea alba above the umbilicus. Longitudinal bulgings of the linea alba are occasionally called herniæ, but they are not herniæ in the true sense of the word, because there is no defect in the transversalis fascia. These bulgings are caused by a wide separation of the recti within their sheaths.

Because of their greater frequency above the umbilicus, these herniæ have also been called "epigastric herniæ." Epigastric herniæ vary greatly in size; some may be no larger than a pea, others again may attain the size of a fist. The larger sizes are very apt to occur in the immediate vicinity of the umbilicus; in fact, it is still a question whether these are not really umbilical herniæ. The greater majority, however, are very small; in fact many are so small that it is questionable whether they are herniæ in the true sense of the word. In most of the cases that I have operated upon I have failed to convince myself that prior to the operation there existed a true hernia with a true sac.

Surgical Anatomy.—The linea alba, situated in the midline of the abdomen between the two recti muscles, is an aponeurotic structure formed by the union of the sheaths of the recti on either side. It is broader above the umbilicus than below; and is in relation posteriorly with the peritoneum, but separated from it by the transversalis fascia.

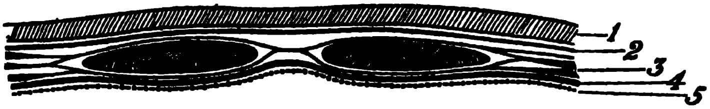

FIG. 71.—DIAGRAMMATIC CROSS-SECTION OF ANTERIOR ABDOMINAL WALL, ILLUSTRATING THE FORMATION OF THE LINEA ALBA. 1, Skin and subcutaneous fat; 2, superficial fascia; 3, abdominal muscles; 4, transversalis fascia; 5, peritoneum.

Figure 71 shows schematically not only the formation of the linea alba, but also its relationship to the transversalis fascia and peritoneum.

As in other parts of the abdomen, the blood vessels run between the peritoneum and the transversalis fascia. Normally, the linea alba above the umbilicus is perforated by numerous blood-vessels. These vessels must of necessity perforate the transversalis fascia; in so doing, they receive the customary outward prolongation of the transversalis fascia. At the level of one of these vessels, therefore, the linea alba should be represented schematically as in Figure 72.

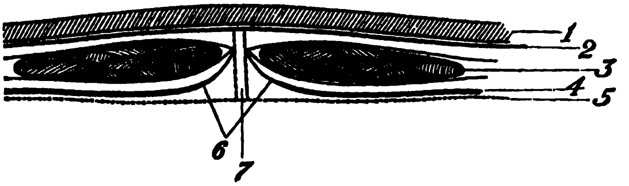

FIG. 72.—DIAGRAMMATIC CROSS-SECTION OF ANTERIOR ABDOMINAL WALL, ILLUSTRATING THE LINEA ALBA, AT A POINT WHERE IT IS PIERCED BY A BLOOD-VESSEL. Note outward prolongation of the transversalis fascia. 1, Skin and subcutaneous fat; 2, superficial fascia; 3, rectus abdominis; 4, transversalis fascia; 5, peritoneum; 6, outward prolongations of transversalis fascia; 7, artery piercing linea alba.

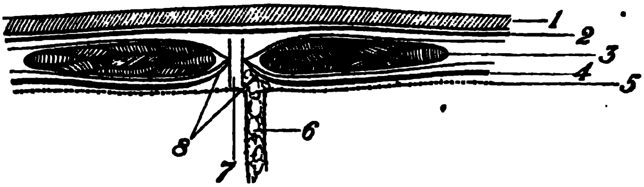

FIG. 73.—DIAGRAMMATIC CROSS-SECTION OF ANTERIOR ABDOMINAL WALL, ILLUSTRATING THE LINEA ALBA, AT A POINT WHERE IT IS PIERCED BY A BLOOD-VESSEL, AND SHOWING, ALSO, THE FORMATION OF THE FALCIFORM LIGAMENT OF THE LIVER. 1, Skin and subcutaneous fat; 2, superficial fascia; 3, rectus abdominis; 4, transversalis fascia; 5, peritoneum; 6, falciform ligament of the liver; 7, artery piercing the linea alba; 8, outward prolongations of transversalis fascia.

The space between the posterior sheath of the rectus and the transversalis fascia is very narrow. Indeed, the space is purely a hypothetical one. Furthermore, if it is considered, as I have shown upon a previous occasion, that at the point where the vessel pierces the transversalis fascia, there is an outward prolongation of this structure, even this hypothetical space disappears, because at this point the linea alba and the transversalis fascia are joined. I have gone at some length into explaining an apparently very trivial point; but this point is of the greatest importance, because it enables us to explain certain peculiarities of an epigastric hernia.

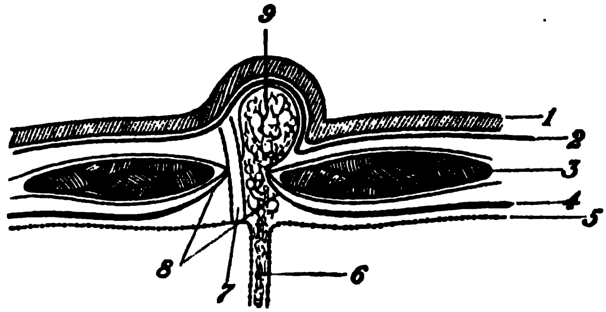

Fig. 74.—Diagrammatic Cross-section of a Hernia of the Linea Alba, Illustrating Its Coverings. 1, Skin and subcutaneous fat; 2, superficial fascia; 3, rectus abdominis; 4, transversalis fascia; 5, peritoneum; 6, falciform ligament of the liver; 7, artery piercing linea alba; 8, outward prolongations of transversalis fascia; 9, hernia of the linea alba.

The hole in the transversalis fascia through which a vessel passes to the surface is a weak spot, and it requires merely an increase in the intra-abdominal pressure for the nearest subjacent structure to be forced into it.

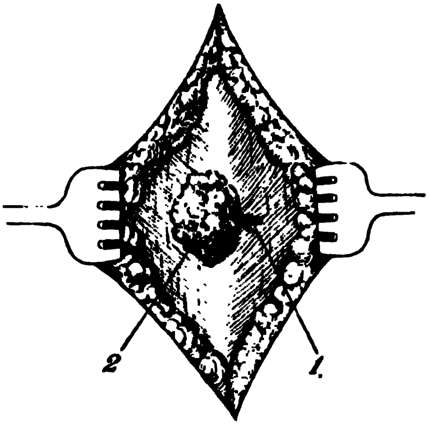

Fig. 75.—Moschcowitz's Operation for Hernia of the Linea Alba. 1, Artery piercing linea alba; 2, properitoneal fat continuous with the falciform ligament of the liver.

And now I wish to call attention to another anatomical point, the importance of which has not been generally recognized; namely, that in the midline of the abdomen, or rather slightly to the right of the linea alba, there is attached the falciform ligament of the liver. This ligament is composed of two layers of peritoneum, inclosing considerable adipose tissue. Anteriorly this adipose tissue is in close juxtaposition with the transversalis fascia of the abdomen at the linea alba.

A diagrammatic horizontal cross-section of the linea alba at the point where it is pierced by a blood-vessel can, therefore, be illustrated as in Figure 73.

Given a hiatus in the transversalis fascia, made by the piercing of a blood-vessel, it is manifest that the first tissue that can be forced through this opening would be the peritoneal fat inclosed in the falciform ligament. An ordinary epigastric hernia would, therefore, in a diagrammatic cross-section, appear as in Figure 74.

The holes in the transversalis fascia are very small; the fascia and the other component parts of the linea alba are strong and inelastic. These facts explain why the so-called epigastric herniæ rarely attain a very large size.

As a result of my observations upon epigastric herniæ, I am able to answer unequivocally that I have never failed to isolate a distinct large vessel coming through the hiatus, accompanied by a larger or smaller piece of fat, directly continuous with the fat of the falciform ligament.

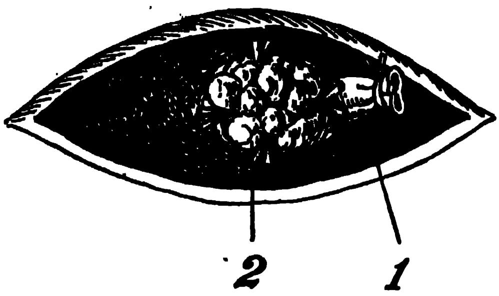

Fig. 76.—Moschcowitz's Operation for Hernia of the Linea Alba, Showing the Transverse Slit in the Linea Alba. 1, Ligated artery; 2, properitoneal fat ligated in four sections.

There is almost never a distinct hernial sac present. Indeed, if one works exactly in the midline, or a little to the right of it, the peritoneal cavity will never be entered, a very puzzling circumstance to one who is not acquainted with the pathological anatomy of these herniæ. If one insists on opening the peritoneum, this can be done only along the left margin of the hernia.

In the symptomatology of these cases the gastric distress has been commonly explained as due to the presence of the stomach; but no one, as far as I am aware, has actually observed the stomach in such a hernia. Furthermore, as in most instances there is not even a hernial sac, I do not see how the stomach can enter. Therefore this symptom is more rationally explainable by the simple dragging upon the fat and peritoneum of the falciform ligament.

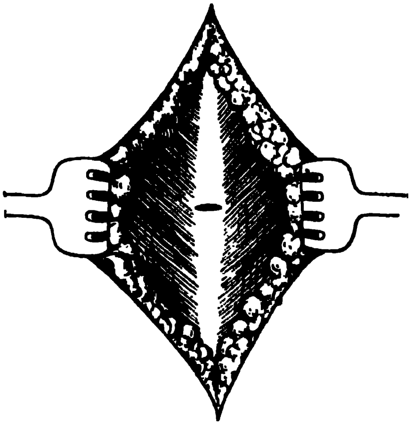

Fig. 77.—Moschcowitz's Operation for Hernia of the Linea Alba. Vessel and fat have been ligated, and the stumps pushed back into the transverse slit in the linea alba.

Treatment.—The operation usually carried out for these herniæ is as follows. The linea alba over the site of the hernia is split. Immediately, the previously mentioned nodule of fat is encountered. The surgeon observes the thin, shiny covering of the fat, and mistakes it for the peritoneum. He incises this covering, and, after a rather summary examination, he at once assumes that he is dealing with adherent omentum. In order to orient himself still better in regard to the true condition of things, he begins a dissection with the object of further opening the peritoneal cavity; this he finally accomplishes after much labor. Of course, he finds nothing, and, therefore, complacently sews up the freshly opened peritoneum and linea alba.

Ever since I have been convinced of the correctness of my observations, I have practiced the following simple procedure: A small vertical incision is made over the center of the so-called hernia. The skin and subcutaneous fat are divided and retracted, thereby exposing a lump of fat. Search is now made for the blood-vessel previously mentioned; usually it is found upon the left side of the protrusion; this vessel (Fig. 75) is caught and ligated. The fat is now teased apart, in order that the operator may be absolutely convinced that there is no true sac. The shreds of fat are ligated to obviate secondary hemorrhage (Fig. 76). The ligatures are placed close to the bottom of the hole in the transversalis fascia. The stumps are now pushed back into the hole (Fig. 77) and the latter closed with 1 or 2 stitches (Fig. 78). Finally the skin is closed in the usual manner.

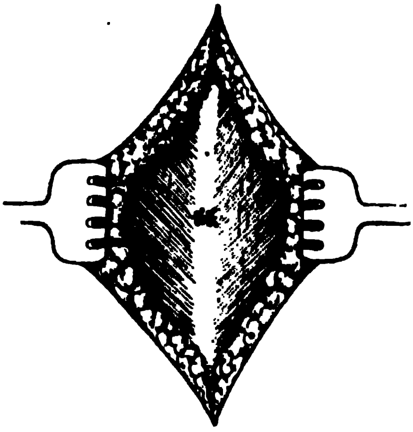

Fig. 78.—Moschcowitz's Operation for Hernia of the Linea Alba. Opening in linea alba closed by two sutures.

On theoretical grounds it may be argued that the procedure just described is faulty, because of the possibility remaining that the fat is merely reduced into the space between the transversalis fascia and posterior sheath of the rectus. In order to combat this argument, I refer to my previous observations, represented in Figure 72. It is seen that, owing to the outward direction of the transversalis fascia, there is a blending of the transversalis fascia and sheath of the rectus; therefore, the stumps of fat and ligatures cannot be pushed anywhere except into the properitoneal space. The sutures which close up the hole grasp all the component parts of the linea alba at that particular point, namely linea alba plus transversalis fascia.

Strangulation is exceptionally rare in epigastric herniæ, but that it can occur is amply proven by an interesting case reported by Hotchkiss (28). A similar case was operated upon by me (52).

LATERAL VENTRAL HERNIA

Analogous to epigastric hernia, which occurs in the median line, there are occasionally met with very small herniæ at the outer edge of the sheaths of the recti. These occur most frequently below the umbilicus, and may aptly be compared to direct inguinal herniæ in a very high situation. They are very rare and are rather difficult of recognition. Their treatment, when recognized, offers no particular difficulties.

OBTURATOR HERNIA

An obturator hernia is one that passes through the obturator canal, an opening situated in the upper and outer part of the obturator membrane, which fills the obturator foramen.

Surgical Anatomy.—Normally the obturator canal is occupied by the obturator vessels, enclosed in a sheath-like prolongation of the pelvic fascia, the obturator nerve, a small quantity of fat, and occasionally a small lymphatic gland. The *canal is covered internally* by peritoneum; *externally* by the *pectineus muscle;* the vessels pass through an interspace in the obturator internus.

The pathogenesis of an obturator hernia is identical with that of all other herniæ. The obturator vessels running between the peritoneum and transversalis (pelvic) fascia perforate the transversalis fascia in order to reach the thigh. A hiatus in the transversalis fascia is thus formed, through which a hernia may develop. As in other hernial sites, the obturator vessels, after piercing the transversalis fascia, receive a sheath-like prolongation from this fascia. Given sufficient cause, a hernia develops, and a small diverticulum of the pelvic peritoneum is forced alongside of the vessels into the obturator canal. If, in addition, a part of an intra-abdominal viscus becomes engaged, we have a complete obturator hernia. On account of their close proximity, the hernial contents are not infrequently portions of the female genital tract, such as the tube, ovary, or bladder; Richter's herniæ have been described in a number of instances.

Contrary to the view generally held, the obturator nerve does not run with the vessels, but is separated from them by the pelvic fascia. Nevertheless, the nerve runs in such close proximity that the hernia may exert pressure upon it, causing the classical Howship-Romberg symptom. This symptom is a characteristic radiation of pain along the inner surface of the thigh, as far as the knee-joint.

Obturator herniæ are very small, as a rule; furthermore, they are covered externally by the fairly strong pectineus muscle. These reasons explain why an obturator hernia only exceptionally makes a visible swelling. In very rare instances an obturator hernia may attain considerable size; in such instances the overlying pectineus muscle becomes stretched, the obturator hernia becoming not only palpable but visible.

Obturator hernia is extremely rare in the male sex; in the female it is a malady limited practically to the aged. Obturator hernia may be bilateral. It is notable that an obturator hernia is very frequently associated with other herniæ. Owing to its small size, the diagnosis of this variety of hernia is but rarely made. Most cases come to operation in a condition of strangulation. The diagnosis even then is rarely made before operation. The patient is operated upon for an intestinal obstruction, and the exact diagnosis is made only during the search for the obstruction.

Treatment.—The abdominal end of the canal is situated at such a depth that, even after complete division of the overlying pectineus muscle, the neck of the sac can be properly ligated only with difficulty, if at all.

Owing to the proximity of the obturator vessels when operating upon a strangulated hernia, there arises the additional difficulty of properly incising the strangulating ring.

The best course, therefore, to pursue is to perform a laparotomy. Laparotomy is also recognized as the best method by Gelpke (17) and Grüneisen (21). With the patient in Trendelenburg's position, the afferent and efferent loops of the strangulated hernial contents are delivered, with or without division of the strangulating ring. Injury of the vessels of the nerve can be readily avoided. All manipulations that may be called for upon the strangulated contents can be carried out with perfect ease and safety. Finally the hernial sac is withdrawn and its peritoneum split, so as to expose the hole in the transversalis fascia; this is closed with Pagenstecher linen or chromicized catgut. Finally the sac is extirpated and the peritoneum closed.

When dealing with a strangulated hernia, it is important to remember that, normally, the obturator vessels are branches of the internal iliac vessels; they are, therefore, situated somewhat behind the neck of the sac. Not infrequently the obturator artery is a branch of the deep epigastric or even the external iliac artery, and then it is more likely to lie in front. Attention is called to this point in order that accidental injury of the vessels may be avoided.

GLUTEAL HERNIA; SCIATIC HERNIA

These herniæ are exceedingly rare and will, therefore, not be discussed at very great length. Possibly owing to their rarity, even the nomenclature of these forms is not established.

The posterolateral part of the pelvis, in the neighborhood of the sacrosciatic notches, harbors 3 foramina (occupied by 3 vessels), all of which may become the site of hernia.

1. The gluteal artery, which is a branch or continuation of the posterior division of the internal iliac artery, passes out of the pelvis through the greater sacrosciatic notch, above the pyriformis muscle. This artery may be accompanied by a hernia, which, therefore, may properly be called a "superior gluteal hernia."

2. Below the pyriformis muscles, there pass out several vessels, viz. the sciatic, internal pudic, and inferior gluteals, any one of which may be accompanied by a hernia. Some authors call all of these herniæ "sciatic herniæ"; others prefer to call them "inferior gluteal herniæ," restricting the former name to the following variety.

3. A sciatic hernia is a hernia which passes through the lesser sacrosciatic notch, accompanying the internal pudic vessels as they reënter the pelvis. This hernia is occasionally of very large size and may form a visible pendulous tumor in the perineal region. By some authors it is regarded as a perineal hernia.

The first 2 varieties are usually very small and are deeply buried beneath the gluteus maximus and medius muscles; for these reasons the diagnosis is well-nigh impossible. If strangulated, the operative diagnosis is usually that of intestinal obstruction, the cause of which is only determined after laparotomy.

Treatment.—On account of the great depth, the best course of procedure is by laparotomy; the subsequent operative steps are those described for obturator hernia.

DIAPHRAGMATIC HERNIA

My experience with diaphragmatic hernia is limited to 2 cases, both of which were of the traumatic variety. Traumatic diaphragmatic herniæ differ, however, from the non-traumatic variety, in that they are usually devoid of a hernial sac, and, therefore, are really prolapses of intra-abdominal viscera into the pleural cavity.

All cases of diaphragmatic hernia can be divided into 2 classes, i. e. (1) true, and (2) false diaphragmatic hernia.

1. A "true" diaphragmatic hernia is one which has a complete peritoneal sac. In the subsequent growth the hernia pushes forward the overlying pleura; such a hernia has, therefore, for its coverings two serous layers.

2. A "false" diaphragmatic hernia is one which is devoid of any sac. These are always traumatic in origin, and should in consequence preferably be classified with the prolapses. The differentiation between true and false diaphragmatic hernia is easy in recent cases; but in cases of long standing, the decision is not so readily made, because the prolapsed hernial contents become covered by a pseudoperitoneal sac. Clinically the diagnosis of a false diaphragmatic hernia is justifiable only when there is positive evidence of a penetrating trauma.

From a developmental aspect, all cases of diaphragmatic hernia may be divided into 2 further classes, namely (1) congenital, (2) acquired.

I. CONGENITAL DIAPHRAGMATIC HERNIA

Congenital diaphragmatic herniæ are very rare. They are rarely diagnosed and practically never came to operation. For these reasons a lengthy description is not necessary. Congenital diaphragmatic herniæ may be due to congenital defects of the diaphragm of larger or smaller extent. They may also be true or false, depending upon the presence or absence of a peritoneal sac.

II. ACQUIRED DIAPHRAGMATIC HERNIA

All cases of acquired diaphragmatic hernia may be divided into 2 classes. 1. True acquired diaphragmatic hernia. 2. False acquired diaphragmatic hernia.

1. **True Acquired Diaphragmatic Hernia.**—A true acquired diaphragmatic hernia is one in which there is a protrusion of intra-abdominal contents into an acquired sac. This sac may be acquired in 2 different ways.

(a) The diaphragm and its abdominal and thoracic fascia may be diseased, for instance, by a gumma; when such a gumma is absorbed, there may remain behind a *locus minoris resistentiæ*, into which the peritoneum and intra-abdominal contents are protruded. This is manifestly a very rare occurrence.

(b) The pathogenesis of the second and more frequent variety may be explained in the following manner: The diaphragm is covered practically throughout its entire extent by peritoneum; underneath this peritoneum there is again the continuation of the transversalis fascia, which is here called the diaphragmatic fascia. If the diaphragm and diaphragmatic fascia are carefully examined, it is seen that they are perforated to permit the passage of certain structures either from the thorax to the abdomen, or reversely. These perforations are the sites for the subsequent development of an ordinary acquired diaphragmatic hernia.

The hiatuses in the diaphragm are the following:

1. The hiatus caused by the perforation of the superior epigastric artery, which is a continuation of the internal mammary. This hiatus is situated between the sternal and costal portions of the diaphragm.
2. The hiatus caused by the perforation of the musculophrenic artery, also a branch of the internal mammary artery.
3. The esophageal hiatus.
4. The aortic hiatus (this is really behind the diaphragm, but is mentioned for completeness' sake).
5. The hiatus for the vena cava.
6. The foramen of Bochdalek.

Owing to the presence of the liver, herniæ through the foramina on the right side of the diaphragm occur only very rarely. Herniæ through the remaining foramina have been described with greater or lesser frequency.

2. **False Acquired Diaphragmatic Hernia.**—The pathogenesis of false acquired diaphragmatic herniæ may be explained in 2 different ways, depending upon the nature of the trauma.

(a) The trauma may be penetrating, e. g. a stab wound which pierces both the thorax and diaphragm and its two serous coverings, i. e. the pleura and peritoneum. Upon withdrawal of the offending instruments there immediately occurs a prolapse of some of the intra-abdominal contents into the pleural cavity. The thoracic incision may heal, but the intra-abdominal contents remain unreduced in the pleural cavity, or may even increase in amount.

(b) If the trauma is not penetrating, the pathogenesis is the following: Assuming a localized crushing force against the thorax, a rib is fractured and the diaphragm is torn away from its origin. The wound in the diaphragm heals, leaving a weak cicatrix, which eventually gives way and bulges into the thorax, with protrusion of more or less of the intra-abdominal viscera. This hernia may or may not be visible externally, depending upon how firmly the rib or intercostal muscles and endothoracic fascia have healed. The trauma may or may not tear the pleura and peritoneum, and upon this circumstance depends whether the hernia is a true hernia or a spurious one.

This description has not exhausted by any means all the possibilities of diaphragmatic hernia.

The contents of a diaphragmatic hernia vary in size and amount. Frequent contents of such a hernia are the stomach, transverse colon, and omentum; this accounts for the frequency of gastric symptoms. Other important physical signs are the displacement of the heart and pericardium to the opposite side; a greater or smaller area of tympany in the thorax; embarrassment of the respiration, particularly when the stomach is distended. X-ray pictures with bismuth per os and per rectum may be of material assistance in clearing up an otherwise doubtful diagnosis.

TREATMENT OF DIAPHRAGMATIC HERNIA

Cases of large congenital diaphragmatic hernia, with large defects in the diaphragm and prolapse of a large part of the intestinal tract, are either incompatible with the continuation of life or are the gravest of operative risks.

The operation for other forms of diaphragmatic hernia is frequently followed by excellent results.

There are 2 methods of approach, namely, the "transpleural" and the "transperitoneal." With recently discovered methods of anesthesia, such as the Meltzer-Auer insufflation anesthesia, or in positive or negative pressure cabinets, the transpleural route is gaining in favor; first, because it admits of better approach; second, it admits of freer manipulation of the hernial contents in order to free and reduce them; and finally it permits of a more adequate closure of the hernial openings, not only in the diaphragm, but also in the thoracic wall.

An adequately long incision is made in the proper intercostal space. It is not absolutely necessary to resect a rib, and with a properly applied rib spreader ample exposure can be obtained; if this is insufficient, 1 or even 2 ribs may be resected, or divided near the 2 extremities of the incision. The one danger of the operation at this stage is an acute pneumothorax; but this danger can be very readily controlled if intratracheal insufflation anesthesia or pressure cabinets are used.

The opening in the diaphragm is now exposed. If the hernia is a true hernia, it is now necessary to divide 2 serous surfaces, first the diaphragmatic pleura, and secondly the diaphragmatic peritoneum; if the hernia is a spurious hernia, the hernial contents lie exposed before us. All adhesions are liberated, and the contents carefully returned to the abdomen. The redundant portions of the sac are now trimmed away, and the hole in the diaphragm is sutured, each suture grasping in its bite pleura, endothoracic fascia, diaphragm, diaphragmatic fascia, and peritoneum.. With the intratracheal insufflation anesthesia, or with the pressure cabinet, the lung is now expanded fully and the thoracic opening closed. The question of introducing or omitting drainage of the pleura cannot be discussed at this place.

If the transperitoneal route has been selected, all these steps have to be carried out at a great depth and more or less blindly. A somewhat better approach can be gained by a temporary resection of the costal arch, after the method of Marwedel.

VENTRAL HERNIA

This name is restricted to herniæ that arise in the cicatrix of a previous laparotomy. They may occur in any part of the abdomen where a laparotomy has been performed; on this account, the surgical anatomy of such a hernia varies with the particular location.

Varieties.—Pathologically and etiologically, however, we may have 4 different varieties.

1. Herniæ which follow a clean laparotomy, and in which perfect primary union was obtained. The hernia may be due to various circumstances: (a) Imperfect suturing; this very frequently resulted in former years, when most laparotomy incisions were sutured with through-and-through sutures. The resulting scar soon gave way and was followed by a hernia. (b) Improper suture material; for instance, improperly prepared catgut or catgut of insufficient strength. Such catgut may become absorbed before firm union has taken place. (c) The sutures may have been tied too tightly, and may cut through the tissues, thus weakening the cicatrix. (d) Postoperative distention or vomiting may put such a strain on the sutures that the result will be as described under (c). Cases of subcutaneous prolapse of the intestines occur also in this manner.

2. Incisions in which an infection of the wound has occurred, with subsequent abscess formation. The fascial structures and muscles may slough, thus taking away the most important supporting element.

3. Incisions which require drainage. In former years, when more massive drainage was employed, postoperative herniæ were commonly seen. Nowadays comparatively little drainage is used, and the wound is accurately sutured around the drain. In many operations the drainage is so disposed that the

incision is closed entirely, and the drainage led out through another opening, e. g. vagina. We have also learned to make our incisions so that, even if drainage is used, the opening left by the drain has a better chance to close in a firm manner, e. g. the McBurney, Kammerer, or Pfannenstiel incisions. Furthermore, we have also learned that long-continued drainage is useless; it is, therefore, removed much earlier, thus giving the different layers a better opportunity to unite.

4. Cases in which the abdominal walls cannot be sutured together. Those cases, happily now discarded, in which no part of the abdominal wall was sutured, are not referred to here; rather, cases in which, for instance, a portion of the entire abdominal wall must be sacrificed. This sacrifice is necessary in cases of sarcoma of the abdominal wall, when so much of the abdominal wall is resected that no amount of stretching or plastic work can make an adequate closure; only skin covering the defect.[1]

Naturally the herniæ just described are always of traumatic origin, the trauma in this instance being the surgeon's knife. Occasionally there are also met with traumatic herniæ in various parts of the abdomen. Formerly all herniæ were looked upon as traumatic, but this view has been discarded, more particularly in countries where the labor insurance laws are properly enforced. The abdominal parietes may be injured either openly or subcutaneously, either by having dull or even pointed bodies—for instance, horns of animals—impinge upon them or by running against sharp projecting bodies. Occasionally we may have an indirect rupture of the parietes, as from the contraction of the abdominal walls when falling from a height.

If all the parietal planes are injured, we may have not a hernia, but a complete prolapse; if the peritoneum and other parts of the parietes are torn, but the skin remains intact, we will have a subcutaneous prolapse; but if the peritoneum remains intact, we will have a hernia.

Treatment.—The most important feature of the operation is the proper exposure of the hernial opening. In order to accomplish this, it is important to make an adequate incision, so as to expose the normal anatomical parts as they surround the hernial ring. The peritoneum is opened, all adhesions liberated, the hernial contents reduced, and the peritoneum is closed by a running suture of catgut. The various abdominal layers are then sutured together in their normal relationship, with or without overlapping, with chromicized catgut of sufficient strength.

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[1] There is still another form of hernia which is usually classified in this group, which should not, however, be regarded as a hernia in the true sense of the word. I refer to those cases in which the motor nerves to a single muscle, or even to a group of muscles, have been inadvertently divided and not immediately repaired by suture. Such muscles become paretic and atrophic; the underlying transversalis fascia bulges to a greater or lesser extent, but a true hernia never results.

LUMBAR HERNIA

This is a hernia of rare occurrence, but it has received considerable attention from surgeons, particularly during recent years.

Formerly it was held that a lumbar hernia occurred only through the triangle of Petit, i. e. the place situated above the crest of the ilium, bounded in front by the external oblique and behind by the latissimus dorsi, its floor being made up of the internal oblique and transversalis muscles and transversalis fascia.

Subsequent studies, however, have shown that a lumbar hernia hardly ever makes its exit through the triangle of Petit, but through another part of the lumbar region.

The normal course of the lumbar and circumflex iliac arteries has not as yet been studied with sufficient detail. It is quite evident, however, that, being branches of the aorta, they are covered by the peritoneum and lie upon the transversalis fascia. In order to reach the surface they must, therefore, pierce the transversalis fascia. This hole affords the opportunity for the formation of a hernia. There must be openings upon the back and sides of the abdomen through which these vessels penetrate.

A vessel may penetrate at the triangle of Petit; therefore, it is by no means improbable that a hernia may occur through this space. Indeed, there is at least one authentic case published by Dowd (12).

Other openings have also been described. Braun (10) described one in the tendon of the latissimus dorsi; Lesshaft (38) described the trigonum lumbale superius and various other openings. At best, we may say that the surgical anatomy of these parts has not as yet been perfectly described.

Treatment.—Operations with plastics from the surrounding fascial, tendinous, and muscular structures have been reported. No specific directions can be given; each operation must be governed by the nature of the hernia and the anatomy of the parts.

INTERNAL HERNIA

The name "internal hernia" should be restricted to herniæ in which the sac is formed by normal physiological protrusions of the peritoneum. This name has also been given erroneously to other pathological conditions, as, for instance, to a loop of intestine slipping behind an adhesion, or to a loop slipping through an abnormal opening in the omentum.

An internal hernia can occur only in the following locations:

1. Through the foramen of Winslow, into the lesser peritoneal cavity.
2. At the junction of the duodenum and jejunum. There are several small fossæ in this region. The most important of these is that which extends

retroperitoneally toward the left side. It is characterized by the fact tha the inferior mesenteric vein runs parallel to the anterior edge of the mouth o the sac. The sac may be dragged out of the way by the growing hernia, bu the presence of the vein encircling the anterior half of the ring serves as a excellent landmark.

3. There are several normal and more or less deep fossæ in the neighborhood of the cecum.

a. A fairly constant fossa situated behind the cecum, the retrocecal fossa.

b. A small fossa situated just superior to the junction of the ileum with the cecum; the superior ileocecal fossa.

c. *A small fossa situated just inferior to the junction of the ileum with the cecum, its inferior anterior edge being made up practically of the mesenteriolum of the appendix, the inferior ileocecal fossa.*

4. Upon the left side of the root of the mesosigmoid there is the mesosigmoid fossa.

5. Very rarely blind fossæ are seen near the vertex of the bladder.

The preoperative diagnosis of an internal hernia is practically impossible. Most of the cases are diagnosed upon the operating table, the preliminary diagnosis being intestinal obstruction of unknown origin.

In size such herniæ may vary between those of the smallest knuckle to those in which most of the small intestine is contained within the hernial sac.

Treatment.—As most cases are operated upon for intestinal obstruction, the operation is one of extreme urgency. A loop of distended and one of collapsed gut will lead to the site of the obstruction. It is best to follow the collapsed loop, as it is technically easier. In cases of strangulated internal hernia we may be able by manipulation and stretching to begin the delivery of the contents; when this first step is successful, the remainder of the hernial contents follows readily; if delivery is impossible, it is necessary to nick the neck of the sac. The only important point to remember is not to injure the subjacent vessels; this is to be specially guarded against in the left-sided duodenojejunal hernia, in which the subjacent inferior mesenteric vessels may be injured. After the intestines have been reduced, the question arises how best to deal with the sac. There are several ways, none of which, however, has been tried with sufficient frequency to enable us to draw definite conclusions.

(a) Extirpation of the sac may be an extremely difficult, if not an impossible matter. The sac may be too large; it may be surrounded by large vessels; and lastly a part of the sac wall may be made up of intestine.

(b) Obliteration of the sac by suture may be dangerous on account of its size, and because of danger of injury to surrounding vessels.

(c) Suture of the neck of the sac may be dangerous on account of large vessels, e. g. inferior mesenteric, running just where the sutures have to be placed; and such a closed sac may be followed by infection and peritonitis.

(d) To leave the sac entirely alone and take chances upon a recurrence of the hernia appears to be the best plan. At most, the mouth of the sac may be closed as far as one is able.

PERINEAL HERNIA

The name perineal hernia should be restricted to those herniæ that appear at some part of the pelvic outlet, but pass out of the true pelvis, either through or between the fibers of the levator ani and the other muscles that together form the so-called "diaphragm of the pelvis." Herniæ that leave the abdomen through the inguinal canal and only secondarily migrate into the perineum are erroneously classed as perineal.

SURGICAL ANATOMY AND PATHOGENESIS

The gross and surgical anatomy of the pelvis and its contents is a large subject and cannot be treated in detail. For our purpose, the following description will suffice:

The bony pelvic outlet is closed in by a muscular diaphragm, composed mainly of the pubic and iliac portions of the levator ani muscle in front, and the coccygeus muscles behind. The superior surface of these muscles is lined everywhere by the pelvic fascia, which is merely a continuation of the transversalis fascia. This fascia is covered on its upper surface by peritoneum.

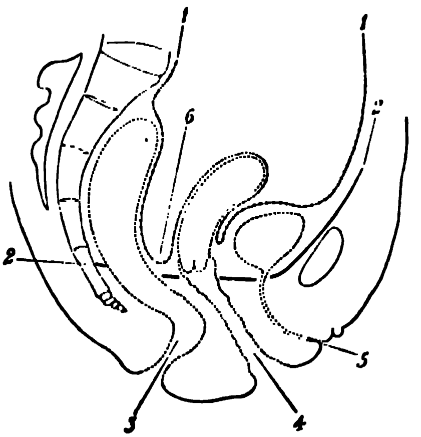

FIG. 79.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF THE PELVIS AND ITS CONTENTS IN THE FEMALE. 1, Peritoneum; 2, transversalis fascia; 3, rectum; 4, vagina; 5, urethra; 6, culdesac of Douglas.

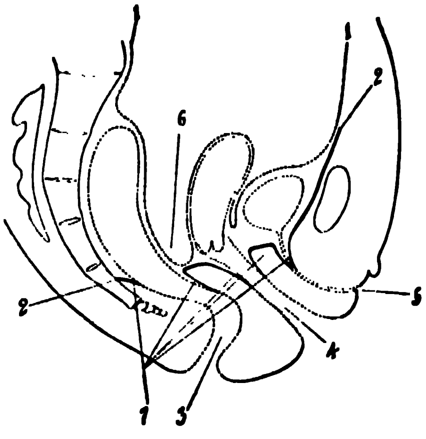

FIG. 80.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF THE PELVIS AND ITS CONTENTS IN THE FEMALE. 1, Peritoneum; 2, transversalis fascia; 3, rectum; 4, vagina; 5, urethra; 6, culdesac of Douglas; 7, outward prolongations of transversalis fascia.

In the course of this article it has already been emphasized that the pathological substratum of every hernia is a hiatus in the transversalis fascia, due to the passage of vessels which pierce it. Now there are not a great many vessels which pierce the transversalis fascia in the pelvic regions, and, therefore, hernia in this region should be exceptionally rare. The pelvic fascia and levator ani are, however, pierced by other structures; this accounts for the occurrence of hernia in these parts with greater frequency than is generally presumed. The levator ani and pelvic fascia are pierced by the urethra and rectum in the male, and by the urethra, vagina, and rectum in the female; it is at these locations, therefore, that we find true perineal hernia.

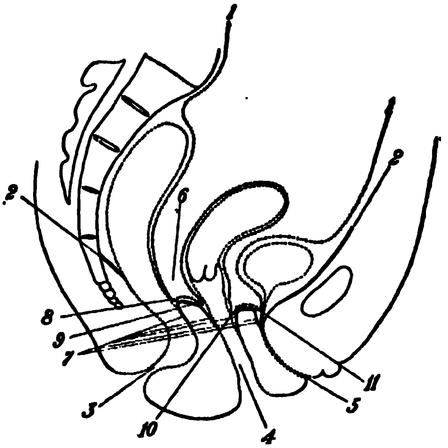

Fig. 81.—Diagrammatic Anteroposterior Section of the Pelvis and Its Contents in the Female. 1, Peritoneum; 2, transversalis fascia; 3, rectum; 4, vagina; 5, urethra; 6, culdesac of Douglas; 7, outward prolongations of transversalis fascia; 8, peritoneum bulging in front of anterior wall of rectum; 9, peritoneum bulging behind posterior wall of vagina; 10, peritoneum bulging in front of anterior wall of vagina; 11, peritoneum bulging behind posterior wall of urethra.

The pathogenesis of these herniæ is that of other herniæ. Just as the intra-abdominal vessels lie upon the intra-abdominal fascia and are covered by peritoneum, so are the larger intestine, uterus, and bladder. Therefore, before these structures can make their exit from within the abdomen, it is necessary that they pierce the transversalis fascia. This condition can best be illustrated by the accompanying diagram (Fig. 79). It is seen that the anterior surface of the suprafascial portion of the rectum, both surfaces of the uterus, and the posterior surface of the bladder are covered by peritoneum. The pelvic fascia is pierced by the outlets of these structures before they can reach the surface; in other words, there is a hiatus in the fascia to permit their escape.

As has been described in other herniæ, the fascia becomes everted and, gradually becoming thinner and thinner, finally merges with the walls of the urethra, vagina, and rectum. In order to be exact, therefore, the diagram in Figure 80 is necessary.

Assuming, either that the pelvic fascia is abnormally weak or that the intra-abdominal pressure is abnormally high, or both, a small process of peritoneum is pushed through these weak spaces. This is the beginning of a perineal hernia. A perineal hernia, therefore, cannot occur behind the rectum or in front of the bladder, for the self-evident reason that there is no peritoneum in these locations. It is evident, therefore, that we can have only the following 4 varieties:

1. In front of the anterior wall of the rectum.
2. Behind the posterior wall of the vagina.
3. In front of the anterior wall of the vagina.
4. Behind the posterior wall of the urethra.

These sites are represented in the accompanying diagram (Fig. 81).

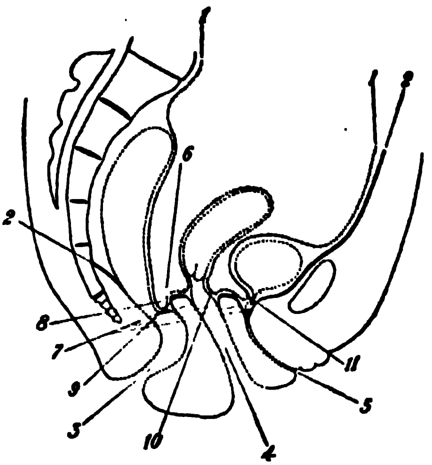

FIG. 82.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF THE PELVIS AND ITS CONTENTS IN THE FEMALE. 1, Peritoneum; 2, transversalis fascia; 3, rectum; 4, vagina; 5, urethra; 6, culdesac of Douglas; 7, hernia into anterior wall of rectum; 8, hernia into posterior wall of vagina; 9, hernia into anterior wall of vagina; 10, hernia into posterior wall of urethra.

Owing to the peculiar anatomical and physiological structure of the pelvis, the subsequent growth of a perineal hernia differs from other types. In every hernia the subsequent growth takes place in the direction of least resistance. This is seen, for instance, in an oblique inguinal hernia, where the hernia grows into the inguinal canal, and subsequently into the scrotum. In a perineal hernia the growth also occurs in the direction of least resistance; it is, therefore, necessary to determine this.

In addition to the transversalis fascia and levator ani, the pelvic outlet is guarded by a layer of strong fascia, which covers the inferior surface of the levator ani, and by several small muscular structures, each covered by its own fascia. It is, therefore, evident that the hernia in its growth will have to overcome the resistance of all these structures. In view of this circumstance, the hernia in its passage seeks the point of least resistance and invaginates the nearest hollow viscus. This step in the development of a perineal hernia can be represented diagrammatically as in Figure 82.

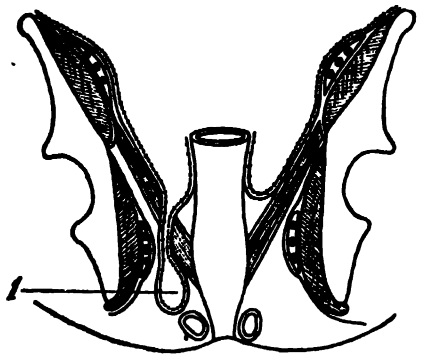

FIG. 83.—PERINEAL HERNIA THROUGH THE FIBERS OF THE LEVATOR ANI (Sultan). 1, Perineal hernia.

In other words, we now have:

1. A hernia into the anterior wall of the rectum.
2. A hernia into the posterior wall of the vagina.
3. A hernia into the anterior wall of the vagina.
4. A hernia into the posterior wall of the urethra.[1]

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[1] There have been described herniæ through defects in the levator ani, or through clefts between the levator ani coccygeus muscles. I believe, however, that these defects are asso-

1. HERNIA INTO THE ANTERIOR WALL OF THE RECTUM; "PROLAPSE OF THE RECTUM"

PATHOGENESIS

In a paper entitled "The Pathogenesis, Anatomy, and Cure of Prolapse of the Rectum" (50), I have discussed this subject at great length. The following is an abstract of that paper:

Figure 84 represents an anteroposterior section of the pelvis. It is intended to present the hole in the pelvic fascia through which the rectum escapes. Figure 85 is intended to present the outward prolongation of the pelvic fascia on to the rectum.

When discussing the pathogenesis of hernia in general, attention was called to the fact that there exist 2 theories as to the origin of every hernia: first, that which regards the sac as a congenital malformation; and, second, that which regards the defect in the transversalis fascia as the predisposing cause. Both these theories are also applicable to prolapse of the rectum.

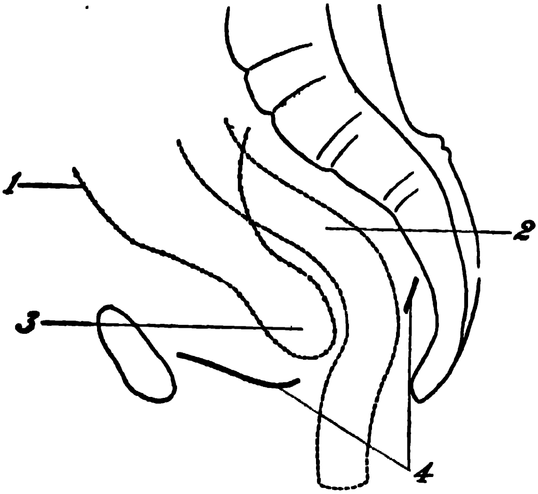

FIG. 84.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF THE PELVIS, TO EXPLAIN PATHOGENESIS OF A PROLAPSE OF THE RECTUM. 1, Peritoneum; 2, rectum; 3, culdesac of Douglas; 4, transversalis fascia.

In early embryological life the peritoneum reaches downward almost to the perineum. Later it becomes shut off and recedes higher and higher. It is quite conceivable that if this shutting off process stop early, the culdesac of Douglas will be deeper than is normal. This affords a substantial basis for the congenital or saccular theory of rectal prolapse. The weak point in this theory is that, as the prolapse of the rectum is hardly ever seen in its earliest stages, consequently the great depth of the culdesac in these cases can merely be surmised. On the other hand, it is well known that the culdesac of Douglas is very deep in cases of prolapse of the rectum; but it cannot be asserted with definiteness that this great depth is due to a congenital malforma-

ciated with defects in the pelvic fascia, which serve to transmit vessels. Any opening of this nature may, in very rare instances, serve as the site of transmission of a hernia. Such herniæ have been described as burrowing a way for themselves into the fatty tissue filling the ischiorectal fossa. I have never seen such a case. The accompanying illustration (Fig. 83), copied from Sultan's "Unterleibsbruche," will serve to explain the anatomy of such a hernia.

tion; on the contrary, it appears to be more likely that its unusual depth is due to its being pushed out in the hernial sac.

The congenital or saccular theory of hernia has never appealed to me except for those cases in which there is no doubt of the congenital nature of the sac, as, for instance, in the so-called "congenital inguinal hernia." On the contrary, I am more inclined to the second theory, namely, that the predisposing cause is a defect in the transversalis fascia.

When all these points are considered, it is seen that Figure 86 is a diagrammatic representation of the first bulging of the peritoneum into the

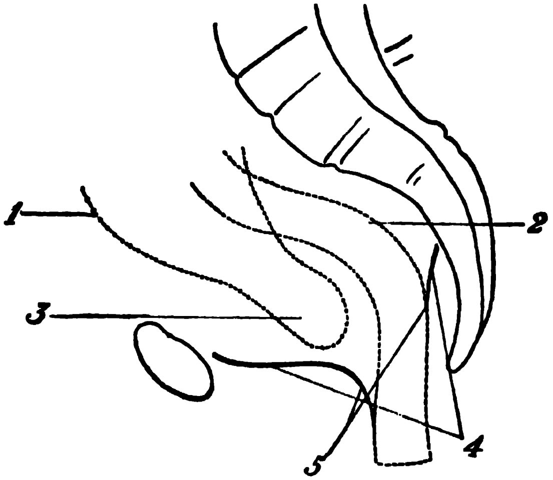

FIG. 85.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF THE PELVIS TO EXPLAIN PATHOGENESIS OF A PROLAPSE OF THE RECTUM. 1, Peritoneum; 2, rectum; 3, culdesac of Douglas; 4, transversalis fascia; 5, outward prolongations of transversalis fascia.

outward prolongation of the pelvic fascia, i. e. of a prolapse of the rectum in its very incipiency.

The subsequent development of the prolapse is most interesting and depends upon definite anatomical facts that must be known in order for the pathological anatomy of prolapse of the rectum to become intelligible. It is important to know:

1. That the peritoneum covering the anterior surface of the rectum is intimately adherent to it. This is important, because it explains why, in spite of the fact that prolapse of the rectum is a hernia, we do not have a distinct and separable peritoneal sac. In other words this hernia is in many respects analogous to a *hernie par glissement.*

2. That the under surface of the levator ani is also covered by a very dense fascia; this with the other component parts of the perineal body, its muscles, and their fasciæ, prevents the progress of the hernia in a downward direction. The intra-abdominal pressure, however, continues irresistibly and, once begun, it continues to push the peritoneal sac onward; and meeting the

strong resistance of the perineum, as already mentioned, it seeks a point of lesser resistance, and invaginates the nearest hollow viscus, the rectum.

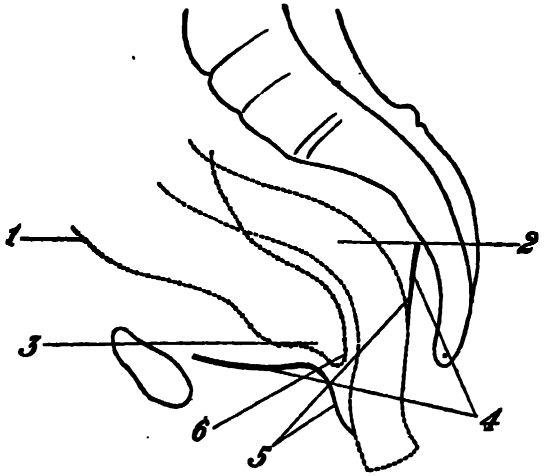

FIG. 86.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF PELVIS, TO EXPLAIN PATHOGENESIS OF A PROLAPSE OF THE RECTUM. 1, Peritoneum; 2, rectum; 3, culdesac of Douglas; 4, transversalis fascia; 5, outward prolongations of transversalis fascia; 6, incipient prolapse of the rectum.

The next step in the formation of this form of perineal hernia, or prolapse of the rectum, is illustrated diagrammatically in Figure 87. When this stage has been reached, there is for a while nothing to prevent the subsequent growth of the hernia and prolapse. The prolapse increases mainly in a posterior direction, until it is arrested, first by the posterior wall of the rectum, and, when this ceases to give support, by the underlying sacrum and coccyx. Figure 88 is a true representation of the hernia and prolapse at this stage.

But the intra-abdominal pressure still continues. The descent of the rectum, being prevented by the sacrum and coccyx, a change in its course ensues, the prolapse sliding along the posterior wall of the rectum, at first in a downward and forward direction and finally backward toward the anus; ultimately the anal opening is also forced, and the prolapse appears externally. This stage is represented in Figure 89.

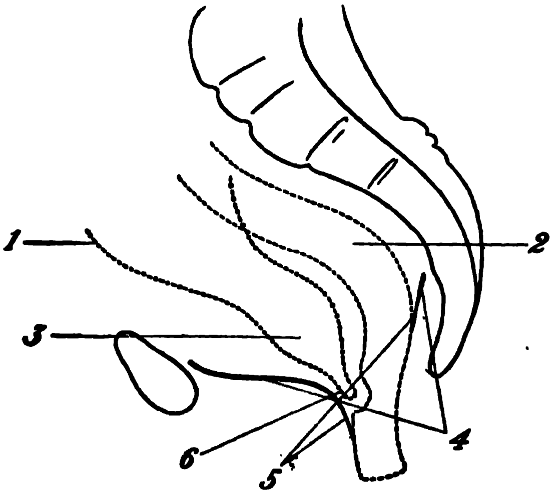

FIG. 87.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF PELVIS, TO EXPLAIN PATHOGENESIS OF A PROLAPSE OF THE RECTUM. 1, Peritoneum; 2, rectum; 3, culdesac of Douglas; 4, transversalis fascia; 5, outward prolongations of transversalis fascia; 6, partial prolapse of the rectum.

By examining the accompanying illustrations, it is seen that thus far only the anterior wall of the rectum is involved. The lowermost part of the rectum being fairly fixed, the prolapse cannot increase at its expense; therefore, in the subsequent growth it can enlarge only by drawing in first the 2 lateral, and finally the posterior walls, until the further drawing in of the bowel is prevented by the firm fixation of the organ.

This has a very important bearing upon the physical signs of complete prolapse, and explains why even the largest prolapses never exceed 5 or 6 in. in length.

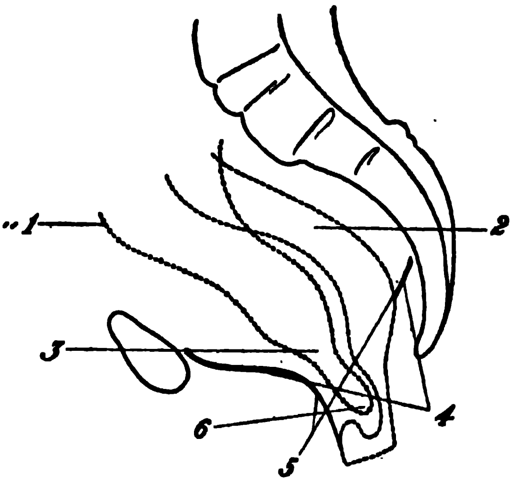

FIG. 88.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF PELVIS TO EXPLAIN PATHOGENESIS OF A PROLAPSE OF THE RECTUM. 1, Peritoneum; 2, rectum; 3, culdesac of Douglas; 4, transversalis fascia; 5, outward prolongations of transversalis fascia; 6, incomplete prolapse of the rectum.

Presuming this pathogenesis to be correct, it is self-evident that the name "prolapse of the rectum" is a misnomer. All the walls of the rectum prolapse only in the very last stage. An infinitely better name would be "perineal hernia into the rectum." But the term "prolapse of the rectum" has become a convention and it is best perhaps to retain it, provided that one constantly bears in mind that it is a true hernia in every respect. In order to complete the nomenclature according to this interpretation, the following subdivisions are suggested:

1. Incipient prolapse of, or hernia into the rectum, illustrated in Figure 86.

2. Partial prolapse of, or hernia into the rectum, illustrated in Figure 87.

3. Incomplete prolapse of, or hernia into the rectum, illustrated in Figure 88.

4. Complete prolapse of, or hernia into the rectum, illustrated in Figure 89.

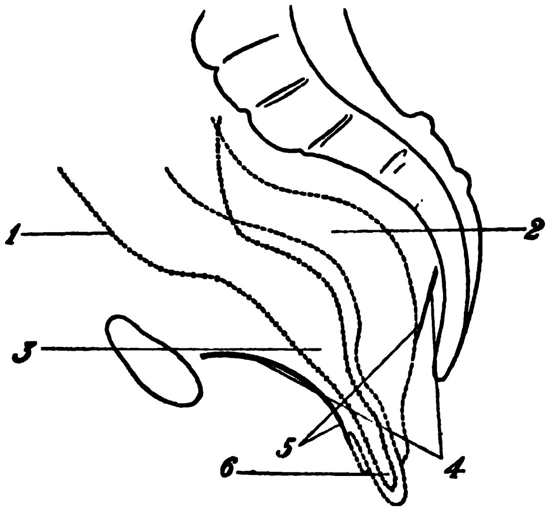

FIG. 89.—DIAGRAMMATIC ANTEROPOSTERIOR SECTION OF PELVIS TO EXPLAIN PATHOGENESIS OF A PROLAPSE OF THE RECTUM. 1, Peritoneum; 2, rectum; 3, culdesac of Douglas; 4, transversalis fascia; 5, outward prolongations of transversalis fascia; 6, complete prolapse of the rectum.

There is not the slightest doubt that all these herniæ actually exist, although, as a rule, the earliest stages cannot be demonstrated. Unlike inguinal hernia, the rectal protrusion in its early stages is invisible, and the patient ascribes his symptoms to hemorrhoids, habitual constipation, etc. If a physician is consulted, the true nature of the malady is overlooked. In the course of time the condition will be recognized earlier; when this occurs, the prognosis and treatment of these cases will be affected materially.

Erroneously several diseases have been grouped under the name "prolapse of the rectum." First, the one under discussion, which we have seen is a true perineal hernia. Second, the one that commonly goes under the name of prolapse of the anus, and which is merely a protrusion of the mucous coat. By some authors this malady has been looked upon as the precursor of a true prolapse of the rectum; such, however, is not the case. Finally, intussusceptions, that prolapse from the anus, have been included with the true prolapses of the rectum.

TREATMENT

It is a well-known axiom in medicine that the greater the number of remedies suggested for the cure of a malady, the less the likelihood of the efficacy of any particular one. This is eminently true in regard to the immense number of measures that have been recommended for prolapse of the rectum.

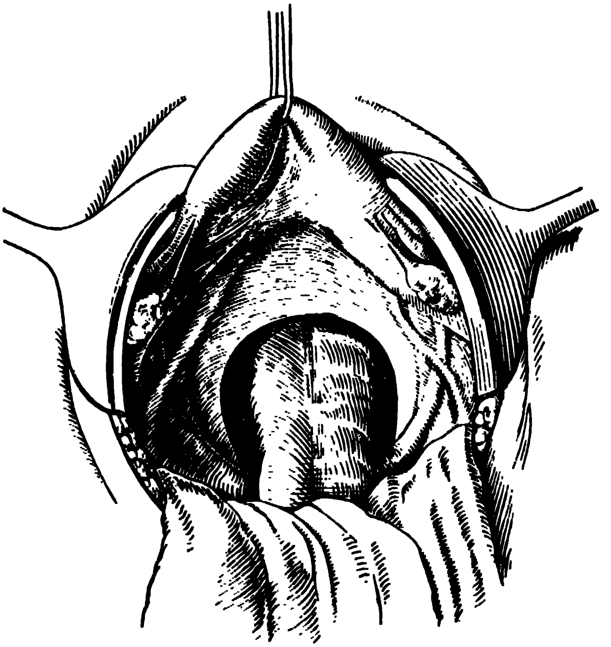

FIG. 90.—MOSCHCOWITZ'S OPERATION FOR PROLAPSE OF THE RECTUM. Exposure of the culdesac of Douglas.

In my paper already referred to (50), a large number of the operations for the cure of prolapse of the rectum were discussed in detail, and their disadvantages pointed out. It was shown that recurrence was the rule after almost every operation advised thus far: at all events this was the experience of myself and my colleagues, in whose hands the best of these operations were tested.

A study of the subject eventually led me to the conclusion that prolapse of the rectum is a hernia in every essential. Utilizing this knowledge as a fundamental principle, I have devised and successfully practiced the following operation:

Operation for Prolapse of the Rectum.—A median abdominal incision is made, extending from the symphysis pubis to the umbilicus. After the abdomen is opened, the patient is placed in an extreme Trendelenburg position. Anyone with any experience knows the depth of the culdesac of Douglas in a normal case, but he will be intensely surprised at its depth in cases of prolapse of the rectum; indeed, it extends several inches beyond the anus. The intestines are now properly packed away. The rectum is pulled up and held taut (Fig. 90). The subsequent steps vary according to the sex of the patient; I shall describe the operation in the female sex.

Pagenstecher sutures are passed circularly around the culdesac of Douglas and tied. The lowermost suture is placed about 1 in. above the inferior extremity of the culdesac. Similar sutures, 6 to 8 in number, are passed at intervals of about 1 in., and continued until practically the entire pouch of Douglas is obliterated (Figs. 91, 92).

It is advisable to try to include in the suture the pelvic fascia, particularly that part which covers the levator ani; how often this attempt is successful is difficult to state.

Theoretically it would be better to split the peritoneum in the depth of the culdesac, and to suture the fascia first. I attempted to do so in one of my earlier cases, but found the procedure so difficult that it was abandoned. A somewhat similar procedure was suggested last year by Jianu (29).

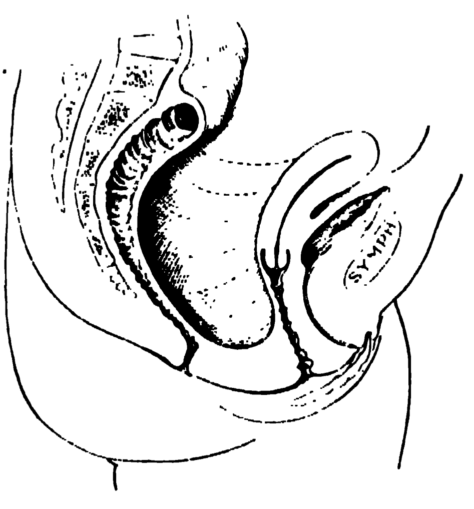

FIG. 91.—MOSCHCOWITZ'S OPERATION FOR PROLAPSE OF THE RECTUM. Dotted lines indicate the sutures passed in the culdesac of Douglas.

When the sutures reach the region of the supravaginal portion of the cervix and body of the uterus, the sutures are anchored to these structures.

When approaching the rectum, the sutures coming from the sides of the pelvis catch the serosa covering it in firm and close stitches. This is done in order to prevent the possible formation of an internal hernia; in addition these lateral sutures also materially aid in fixing the rectum to the sacrum and coccyx.

There are 2 structures which should be avoided, namely the ureters and the internal iliac vessels. The former can be marked by introducing ureteral catheters; the pulsation of the vessels serves as a guide to the latter. Particular attention is to be paid to the triangle formed by the ureter, external iliac, and internal iliac arteries;

when reaching this area, the sutures skip over the ureter, pick up the peritoneum, and skip over the internal iliac artery, as has been indicated in Figure 93. I have never had the slightest accident in any of my cases. In older women the uterus is firmly ventrofixed.

No fixation of the intestine, viz., sigmoid flexure, is undertaken, as it is superfluous.

The abdominal wall is sutured in layers.

The after-treatment is simple. The bowels are neither constipated nor moved purposely; they will generally move of their own accord in less than a week. Most patients require catheterization. In other respects the after-treatment is that of a laparotomy.

RESULTS.—A fairly extensive hospital service, augmented by the courtesy of many colleagues, has afforded me abundant opportunity to study the malady in question, and has also given me a fairly large experience in the operation.

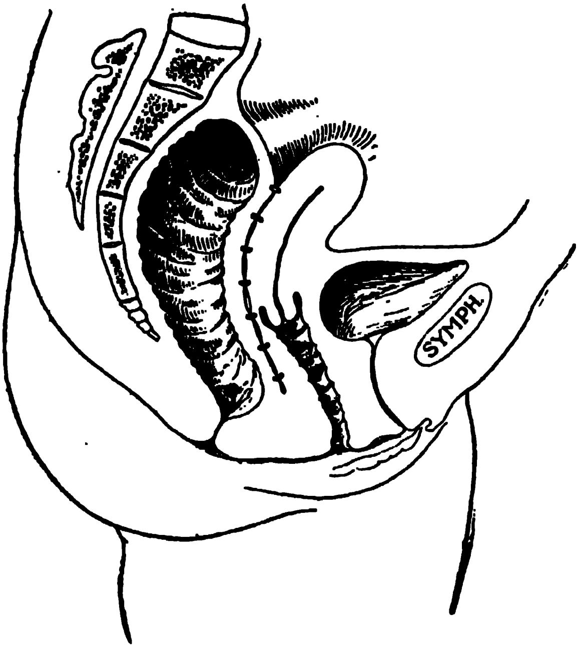

FIG. 92.—MOSCHCOWITZ'S OPERATION FOR PROLAPSE OF THE RECTUM. The sutures are tied, thus obliterating the culdesac of Douglas.

To my mind the operation just described would be ideal, provided we could select our cases and operate only on those illustrated in Figures 86, 87, and 88. After the prolapse has become complete, i. e. when the prolapsed anterior wall has also drawn down the 2 lateral and posterior walls, it may be necessary to add some sort of a plastic or fixation operation. Thus far I have done this in 2 cases only: one case had a perineorrhaphy done upon the gynecological division of Mt. Sinai Hospital.

A total of 15 cases has been operated upon by this method. One case died from causes not connected with the operation.

The final results may be judged from 2 points of view, that of the patient and that of the surgeon. It is surprising that in this instance the patient is better satisfied than the surgeon. In fact, from the patient's point of view, the cures may be estimated at 100 per cent.

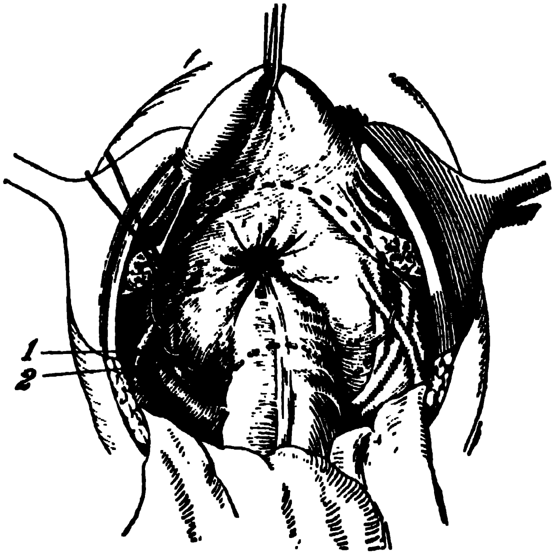

FIG. 93.—MOSCHCOWITZ'S OPERATION FOR PROLAPSE OF THE RECTUM. The method of passing the circular suture in the region of: 1, ureter; 2, internal iliac artery.

From the hypercritical point of view of the surgeon, however, it may be said that, though the symptomatic cure is perfect, the percentage of anatomic cures is not so large, because in about one-third of the cases, when the patient strains the anus opens up, so that a narrow rim of mucous membrane becomes visible. I firmly believe that even this can be corrected by the addition of a small plastic in the cases indicated. I do not believe that this operation is the final step in the treatment of prolapse of the rectum; but it at least is a step in the right direction.

2. HERNIA INTO THE POSTERIOR WALL OF THE VAGINA (SO-CALLED RECTOCELE) AND 3. HERNIA INTO THE ANTERIOR WALL OF THE VAGINA (SO-CALLED CYSTOCELE)

The vagina is firmly fixed by the outward prolongation of the pelvic fascia, and in consequence hernia into the walls of the vagina is rather infrequent, provided this fixation and the pelvic fascia are normal. That it does occur, however, is amply proven by those cases in which we find a total prolapse of the uterus in nulliparous women. Such prolapses may be well accounted for *by so loose fixation of the vagina that there is a hernia both anteriorly and posteriorly to the vagina.* This is the status of affairs only when the pelvic fascia is perfectly normal. Unfortunately, however, the pelvic fascia very frequently becomes abnormal on account of injuries during parturition.

In order to explain my conception of the pathogenesis of these maladies, it may be permissible to picture the mechanism of injuries to the pelvic fascia during labor. The vagina is firmly fixed into the pelvic fascia; the cervix uteri is located just at that part of the pelvis where the vagina is fixed into the pelvic fascia. The cervix dilates in the course of labor, due to contraction of the uterine muscularis; when the cervix is fully dilated the head usually passes through. During this stage of labor the pelvic fascia is dilated to its extreme limit, but it may still be too tight for the advancing head; under this circumstance this fascia tears to a greater or lesser extent. The vagina is, as a rule, very elastic, and will stretch rather than tear; this is why most of the tears of the pelvic fascia are submucous. In the course of time the rupture in the pelvic fascia heals up; but, approximation being poor, there always remains behind a gap of varying extent. It is this gap in the pelvic fascia which now acts as the pathological substratum for the subsequent development of a hernia.

From the mechanism of the original injury we may also deduce that the resulting gap must be of a somewhat triangular form, the base of the triangle being at the vagina, and its apex distally from the vagina, i. e. at the junction of the 2 other sides of the triangle which are formed by the pelvic fascia.

After healing has taken place, the gap is bridged only by a little cicatricial tissue, which is lined above by peritoneum and below by the mucous membrane of the vault of the vagina. But these structures are not sufficient to withstand even the normal intra-abdominal pressure, and very soon the peritoneum lining the upper surface of the gap is pushed against the vaginal wall, and, when this ceases to give support, the corresponding vaginal wall is pushed into the lumen of the vagina, this being the direction of least resistance.

During parturition the overstretched transversalis fascia may tear in any direction radiating from the vagina; the location of the subsequent vaginal hernia will, therefore, depend upon the location of the original tear and the subsequent gap in the pelvic fascia.

1. If the gap is located posteriorly we will get a hernia into the posterior vaginal wall, or a "rectocele" so called.
2. If the gap is located anteriorly, we will get a hernia into the anterior vaginal wall, or a "cystocele" so called.
3. If the pelvic fascia has been torn all around the vagina, we will be more likely to get a circumferential hernia, which is subsequently followed by a uterine prolapse.

In other words, it is my claim that the underlying basis of all these 3 maladies is an injury of the pelvic fascia, i. e. that continuation of the transversalis fascia which lines the upper surface of the levator ani. All the injuries of the other parts of the genital tract are either unimportant in the production of a rectocele or cystocele, or at best only secondary factors. This opinion is based upon the following observations:

1. A rectocele or cystocele not infrequently follows cases of labor in which there was absolutely no visible injury to the genital tract.

2. In many cases the perineal body and outlet of the vagina are completely torn through, even into the rectum, and yet a rectocele or cystocele may not develop.

3. The ease with which even the most extensive perineal tears are repaired.

4. The difficulty with which cystoceles, and more particularly rectoceles, are repaired; this difficulty arises because it is difficult to reach the offending cause, i. e. the tear in the pelvic fascia which lines the "upper" surface of the levator ani. Even if this structure can be reached, it frequently is so retracted that the operative closure of the opening is well-nigh impossible.

The injuries of the pelvic fascia just described may be said to be practically beyond our control; they will happen even with the best of care. But there is another class of injuries, fortunately, however, very rare, which is due entirely to injudicious or clumsy interference with labor. These injuries culminate in a tearing away of the pelvic fascia and even levator ani, not at their vaginal attachment, but at their attachment to the pelvic bones. The resulting hernia is a most extraordinary one; it fills the vaginal outlet and appears in the corresponding labium. Usually the contents are bladder. I have treated one such case that had been operated upon a number of times, followed by the usual recurrence. A slightly better result was obtained by mobilizing the uterus through a laparotomy incision and sewing it into the large defect. Some time after the operation a small hernia again appeared to the median side of the uterus which will perhaps be amenable to treatment by a further vaginal operation.

4. HERNIA INTO THE POSTERIOR WALL OF THE URETHRA (SO-CALLED URETHROCELE)

This is perhaps the rarest of all herniæ. The rarity is accounted for by the comparatively small size of the urethra and, above all, by the fact that the bladder is attached so high up upon the uterus that there is a very large interspace at this part between the peritoneum and the underlying pelvic fascia.

Treatment.—It would carry me too much into the domain of gynecology were I to even attempt a description of the treatment of this condition and those discussed under the preceding heading. I am satisfied with having pointed out a therapeutic principle.

HERNIAL COMPLICATIONS

Every hernia is prone to the development of certain complications. As some of these complications may suddenly assume a grave character, and may become dangerous to life itself, their prompt recognition and differentiation are of vital importance.

I. OBSTRUCTED HERNIA

The sacs of all herniæ, especially large ones, after repeated attacks of inflammation, are liable to the formation of adhesions. In such instances there may be partial or complete constipation. This is true more particularly of herniæ which contain the large intestine, in which the feces are already more or less inspissated. If, in addition, the patient is habitually constipated, the fecal current may cease altogether. Because the same symptom, i. e. obstruction of the bowels, occurs both in obstructed and strangulated hernia, the differentiation between the two is important.

Obstructed hernia may be entirely relieved by massage, kneading of the hernia, cathartics, and enemata; these measures are contra-indicated in a strangulated hernia.

II. INFLAMED HERNIA

Either the sac of a hernia, its contents, or both, may become inflamed from extrinsic or intrinsic causes. The extrinsic causes are trauma, badly fitting trusses, etc. The intrinsic causes are ulcerations of the intestine, perforations by foreign bodies, etc. A not infrequent source is an appendicitis in a hernial sac. A somewhat less frequent cause is the involvement of a hernial sac in a spreading peritonitis from an intra-abdominal infection.

The inflammation may be mild, manifesting itself only by a slight exudation of serum and fibrin, and causing but little inconvenience to the patient. Even mild attacks, however, are frequently followed by the formation of adhesions which bind apposed serous surfaces together. The inflammation may be of a chronic type; an excellent example of this is seen in a localized tuberculosis of the hernial sac or in a general peritoneal tuberculosis involving incidentally the hernial sac. Finally the inflammation may assume a very virulent character; it may, for instance, be caused by a gangrenous appendix or by a perforation of the intestine situated in a hernial sac.

Inflammation is always one of the later accompaniments of a strangulated hernia.

The treatment of an inflamed hernia, provided strangulation has been positively excluded, is entirely expectant. Rest in bed, the application of an ice-bag, attention to the functions of the bowel, and some care in the administration of a suitable opiate are usually successful in combating the milder degrees of inflammation.

If the inflammation is of a chronic nature, e. g. a tuberculosis, the radical cure of the hernia, with liberation of the exudate, is indicated. We know from the surgical treatment of peritoneal tuberculosis that such a procedure, in a fair proportion of the cases, is followed by a cure.

If, however, the inflammation is of an acute and progressive character, as one, for instance, caused by a gangrenous appendix or perforation of the intestine by a foreign body, prompt surgical interference and proper treatment of the injured or inflamed intestine are indicated.

III. STRANGULATED HERNIA

The characteristic attribute of a strangulated hernia, as opposed to an obstructed or inflamed hernia, is that there is interference with the blood supply in the involved portion of the hernial contents. The interference of the blood supply is caused by a firm constriction at some part of the hernial passageway. A strangulated hernia is, therefore, also always irreducible. If the strangulation includes part of the intestinal tract, there is also interference with the fecal current.

The mechanism of the strangulation cannot be discussed in this place; suffice it to state that the strangulation usually occurs at one of the rings through which the hernia passes. These rings, as has been pointed out, are usually made up of dense and inelastic fascial structures, and do not dilate when more hernial contents are suddenly forced through the neck of the sac. Some hold that occasionally the strangulation is produced by the neck of the sac itself. If the strangulation is caused by the neck of the sac, it is very probable that the peritoneum forming the neck has been altered by a deposit of cicatricial tissue that renders it inelastic. The strangulation may also occur entirely independent of the normal rings. As already stated, not infrequently the sac contains diverticula, for instance, in umbilical hernia. These may be the cause of the strangulation, independent of the umbilical opening. Cases have been reported in which the hernial contents become strangulated by passing under or over a band. In the sacs of congenital hernia there are frequently found abnormalities, such as constrictions and folds, that may cause strangulation. I have described 2 cases of strangulated congenital inguinal hernia in young infants, in which the strangulation was caused by a constricting ring in the processus vaginalis, situated just above the testis, i. e. at some distance from the external inguinal ring (41).

The cardinal symptoms of a strangulated intestinal hernia are absolute. This rule has certain exceptions. There is a form of hernia in which only a part of the lumen, usually that opposite to the mesenteric attachment, is engaged; this hernia is known as Richter's hernia. (Distinction must be made between Richter's hernia and Littre's hernia. A Littre's hernia is one containing a Meckel's diverticulum.) These herniæ are particularly dangerous because of their small size. For this reason they are very apt to be overlooked, especially if they occur in very stout individuals. They occur most frequently in strangulated femoral and obturator herniæ.

It is self-evident that usually the part situated most distally from the neck of the sac is the one that is strangulated. This rule has one rare exception. *In this form of strangulated hernia, not that part of the intestine is strangulated that is within the sac, but the part that remains within the abdomen.* This form of strangulation is called "retrograde incarceration."

Retrograde incarceration may occur in 2 different ways:

(a) When only the terminal portion of one of the abdominal contents, as, for instance, the omentum, the appendix, or the Fallopian tube, becomes involved. A proximally situated loop of these organs may be prolapsed, but the terminal part still remains within the abdomen and becomes strangulated by the hernial ring.

(b) Two loops of the small intestine are prolapsed, while the intervening ring remains within the abdomen, forming what has been termed a "hernie en W." The connecting loop within the abdomen may become strangulated, while the prolapsed loops are not strangulated. The mechanism of this form of strangulation is still a matter of dispute. That it is rare is conceded by everybody; I have operated upon two cases of this nature.

TREATMENT

Indications and Contra-indications.—Prompt or, better said, immediate release of the bowel from its constriction is absolutely indicated. The terse saying of Strohmeyer is sufficiently emphatic: "**Do not let the sun rise upon a strangulated hernia if first seen at night; and do not let the sun set upon a strangulated hernia if first seen by day.**"

This is one operation in which there are absolutely no contra-indications, except a moribund condition.

The immediate release of the obstruction may be obtained in two different ways; first, by a mechanical reduction of the hernial contents, so-called *taxis;* and second, by an operative reduction of the hernial contents, so-called *herniotomy.*

Taxis.—INDICATIONS AND CONTRA-INDICATIONS.—It is not as easy as may appear at first sight to determine the indication for taxis and herniotomy. It is generally held that taxis may be tried in recent cases of strangulation. Time, however, is a hazardous indicator of the amount of damage done in a strangulated hernia. In a given case strangulation of only a few hours' duration may do more damage than one that has lasted for days. We may perhaps arrive at a more satisfactory decision by discussing the contra-indications to taxis. Taxis should never be attempted when there is the slightest suspicion as to the viability of the gut. Unfortunately we have no definite clinical criteria to indicate the viability of the intestine. In the light of our present knowledge, therefore, the burden of proof is decidedly in favor of open operation. In my opinion the only indication for taxis is when the surgeon sees the patient immediately after the strangulation has begun.

TECHNIC.—An exact anatomic diagnosis of the hernia is essential. The reduction of the hernial contents must manifestly be made in the direction of its passage; therefore, it is essential to know whether the hernia is an oblique or direct inguinal, femoral hernia, etc.

It is advisable to have the bladder emptied. If the vomiting is very severe, the stomach may be washed out.

Taxis should be performed with the greatest gentleness. By rough manipulations irreparable damage may be done. The following are some of the accidents that may occur: Rupture of the intestine; tearing off of the intestine from its mesentery; rupture of the sac with prolapse of the contents into the subcutaneous tissues; tearing away of the sac from its neck; reduction of the hernial sac with its contents into the abdomen, so-called reduction en masse (the latter appears somewhat doubtful to me, as already pointed out on page 65).

In order to insure gentleness, I hold that general narcosis, in spite of its undisputed power to induce complete relaxation, is absolutely contra-indicated.

It is advisable to place the patient so that the abdominal muscles and structures surrounding the hernial ring are as completely relaxed as possible. A slight flexion of the knee, with slight external rotation, will best induce relaxation in all the herniæ occurring in the groin. It is wrong to now attempt to push the hernia back into the abdomen. No progress will be made, and there is likelihood that damage may be done. It is best to first pull the hernia away from the abdomen in the direction in which it has escaped. The neck of the sac is now grasped and steadied with the left hand, while the right hand gradually compresses the hernial contents, particularly in the region of the neck of the sac. If only the smallest part has been reduced by these manipulations, the rest follows very easily. When reduction occurs, the intestine imparts a characteristic gurgle.

As already mentioned, an unfailing accompaniment of a strangulated hernia is congestion. To reduce this congestion cold may be applied. A rapid way of doing this is to cover the parts with several layers of gauze upon which ether is sprayed.

That the administration of cathartics is absolutely contra-indicated before the reduction of a strangulated hernia goes without saying. This also applies to opium or morphin.

Even after a successful taxis, in which perfectly viable gut has been properly reduced, the patient is not entirely out of danger. While the reduced intestine in such is perfectly viable, its mucosa may have been so compromised that eventually it is cast off, leaving behind large, even circular ulcers, which may heal with a stenosis of the lumen, leading eventually to an intestinal obstruction. One such case occurred in my earlier experience.

The contra-indications and dangers of taxis are so numerous that it is not at all surprising that surgeons at the present time give preference to herniotomy.

Herniotomy.—If the patient's general condition warrants it, general anesthesia is administered; if the condition is poor, local anesthesia is preferable.

Up to a certain point the operation of herniotomy is identical with the radical operation of a similar hernia. The point referred to is the division of the constricting ring and the handling of the constricted contents.

Two methods of dealing with the constricting ring are usually described: (1) By cutting from without inward; (2) by cutting from within outward. The first implies division of the constricting ring under the guidance of the eye, and is by far the preferable, if not the only method. It is advisable not to cut more than necessary, in order not to compromise tissues that may be used later in the radical cure.

The second method requires the use of a short, narrow-bladed knife, with a blunt point, a so-called herniotome. This is introduced through the constricting ring, which is divided from within outward. As the introduction and division are done blindly, the intestines may be perforated, anomalous vessels may be injured, etc. For this reason this method has been almost completely abandoned.

After the constricting ring has been properly divided, there should be no trouble in reducing the prolapsed contents. Before reduction, it is necessary to inform oneself of the condition of the intestine. To do so a little more of the intestine is pulled down. First the constriction rings upon the proximal and distal loops are examined, as these are the portions likely to be most damaged; the mesentery is examined to see if there is a thrombosis of the vessels; finally the prolapsed loop itself is examined.

The strangulated loop may appear to the operator in 3 different ways. 1. It may be absolutely viable. 2. It may be absolutely non-viable. 3. Viability may be in doubt.

Viability is recognized by the presence of the characteristic luster of the peritoneum. Viable gut, no matter how congested, very rapidly regains its color after the constriction has been divided. When indented or pinched, the depressions made with the fingers very soon disappear. Peristalsis, which is dormant in the constricted intestine, very soon reappears. All these signs may be accentuated by the application of hot normal saline solution.

Non-viable intestine lacks the characteristics just described. It does not glisten and it is flabby; the characteristics of viability do not re-appear after hot applications. In far advanced cases we may see either one or many small or large perforations. The odor is decidedly fecal, or at least feculent, due to infection with the colon bacillus.

Strangulated omentum is characterized by similar attributes and is treated in a similar manner.

Finally it is necessary to examine the nearest afferent and efferent loops. The afferent loop is greatly distended, and its walls show an exudative inflammation. This exudation may, indeed, be so extensive as to interfere with its viability.

It is not wise to pull out too much of the proximal loop; tension upon the vessels may cause kinking, so that more of the intestine appears to be compromised than actually is the case.

If the prolapsed part is viable, it is reduced; and if the condition of the patient warrants, the radical operation may be proceeded with.

If, however, it is decided that the prolapsed part is not viable, there are several methods open to us. 1. The necrotic part may be left in the wound after properly walling off the rest of the peritoneal cavity; eventually such an intestine will slough off, either entirely or at one or more points, with the formation of a fecal fistula or artificial anus. 2. If the necrotic area is very small, it may be inverted and buried into the intestine, and the lumen of the intestine is immediately reëstablished. 3. Finally the necrotic part of the intestine may be resected and the fecal current reëstablished by an entero-anastomosis (see Intestinal Resection, treated elsewhere in this work). Formerly the formation of an artificial anus was considered to be the proper procedure, but the results, both primary and ultimate, were so poor that at present resection is considered preferable.

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CHAPTER II

OPERATIONS UPON THE STOMACH

JOHN DOUGLAS

Indications for Operative Treatment.—The conditions calling for operative surgery upon the stomach, either immediately on making the diagnosis or after the failure of medical treatment, are:

1. Injuries of the stomach wall, due to contusion or to perforation by a bullet or stab wound.

2. Presence of a foreign body.

3. (a) Chronic ulcer of the stomach or duodenum, demanding gastrojejunostomy or excision or both for its cure, with or without occlusion of the pylorus.

   (b) Ulcer, causing repeated or severe hemorrhage.

   (c) Perforating ulcer.

4. Stenosis of the pylorus, whether due to pylorospasm or cicatricial contraction following ulcer, congenital in origin, or caused by the presence of a benign tumor of the pylorus, requiring pyloroplasty or gastrojejunostomy for its relief.

5. Hour-glass stomach, demanding some form of plastic operation, gastrogastrostomy or gastrojejunostomy.

6. Carcinoma, in which pylorectomy, partial or complete gastrectomy or gastrojejunostomy is indicated.

7. Stricture or carcinoma of the cardiac orifice of the stomach or of the esophagus, demanding the performance of gastrostomy, or, by means of a plastic operation making use of part of the stomach wall for the construction of the lower part of a new esophagus.

8. Gastroptosis.

9. Cardiospasm.

Surgical Anatomy.—For the proper performance of operations upon the stomach a knowledge of its surgical anatomy is essential. The relations of the organ to the abdominal wall and other viscera must be known, especially in case of perforating wounds. The blood supply, location of the vessels and the direction of the lymphatic drainage from the involved area, with the location of the lymphatic glands, are of importance, especially in carcinoma. The relations of the stomach to the peritoneum forming the lesser and greater sac and the relations of the duodenum and first portion of the jejunum to their peritoneal folds, are of importance in the performance of gastrojejunostomy.

RELATIONS TO THE ABDOMINAL WALL AND OTHER VISCERA.—The position of the stomach as a whole changes with inspiration and expiration, contraction and relaxation of the anterior abdominal wall and depends also upon whether the stomach is full or empty. The cardiac orifice is fixed in its position and lies to the left of the tenth dorsal vertebra and behind the chondrosternal junction of the left seventh rib. The fundus of the stomach extends upward to the left beneath the diaphragm and the left costal arch as high as the fifth costochondral junction. The pylorus occupies a position 1 in. to the right of the second (and frequently the third) lumbar vertebra and is partly maintained in this position by the attachment of the second portion of the duodenum. The greater part of the stomach lies to the left of the median line in a vertical or oblique position (rather than in the horizontal position in which it is frequently depicted), and the greater curvature, when the individual is in the erect position and the stomach is distended, from 1½ in. above to 1 in. (3.75 to 2.5 cm.) below the level of the umbilicus. The pyloric end or antrum of the stomach curves upward to the duodenal attachment and lies just to the right of the median line. When empty, the stomach is drawn up from this position, so that the greater and lesser curvatures are higher than just described and away from the anterior abdominal wall. The stomach is in relation anteriorly with the diaphragm, liver and abdominal wall; posteriorly with the diaphragm, spleen, left kidney, suprarenal and pancreas, the large abdominal vessels and solar plexus; below with the transverse colon and mesocolon. The cardiac portion lies just below the heart, and when the splenic flexure of the colon is distended with gas it is in intimate relation with the left portion of the greater curvature.

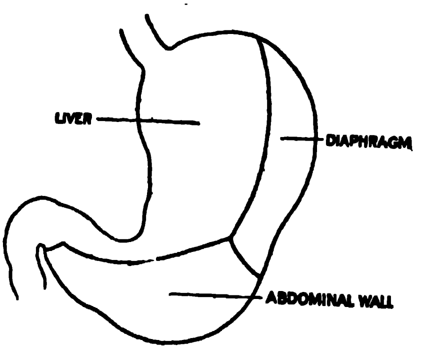


FIG. 1.—RELATIONS OF THE ANTERIOR WALL OF THE STOMACH.

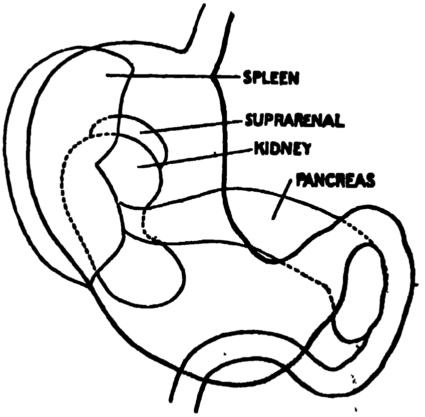
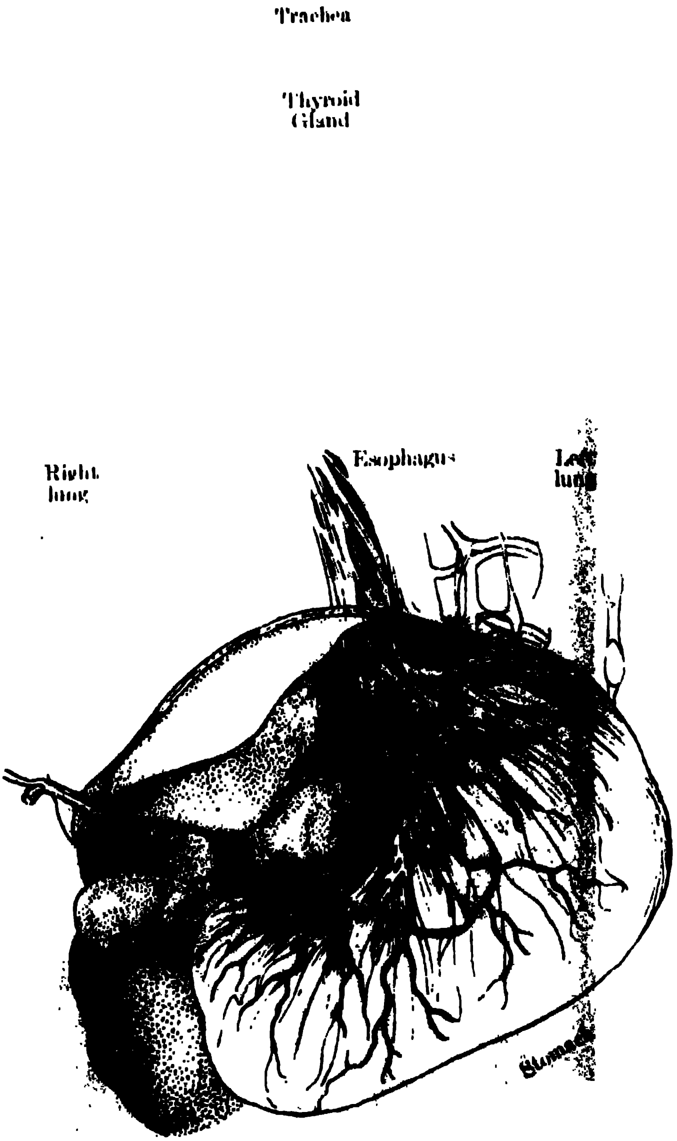


FIG. 2.—RELATIONS OF THE POSTERIOR WALL OF THE STOMACH.

These relations and the accompanying diagrams (Figs. 1 and 2), which are drawn from a series of casts made by Prof. Senior of the N. Y. University and


Trachea
Thyroid Gland
Right lung
Esophagus
Left lung
Stomach

Bellevue Medical College, are given with the stomach in the position it would occupy with the individual in the erect position, as is the rule when a stab or gunshot wound is received, and not in the dorsal position of the operating or dissecting table, as is usually shown. Of course, changes in position, varying in the individual and depending on the causes previously enumerated, must be taken into consideration.

BLOOD SUPPLY.—The blood supply of the stomach (Fig. 3) is from the celiac axis. The *gastric* or *coronary artery* runs from the left end of the lesser curvature to the right, between the layers of the lesser omentum along the lesser curvature, to anastomose with the *pyloric* branch of the hepatic. The hepatic artery also gives off the *gastroduodenalis*, of which the *gastro-epiploica dextra* is a branch. This artery runs along the greater curvature of the stomach from right to left and anastomoses with the *gastro-epiploica sinistra*, a branch of the splenic. In addition there are the vasæ breviæ from the splenic. The vessels requiring ligature in pylorectomy or partial gastrectomy are the coronary, pyloric, gastroduodenalis and gastro-epiploica dextra, and, if the resection is more extensive, the sinistra and branches from the pancreaticoduodenalis.

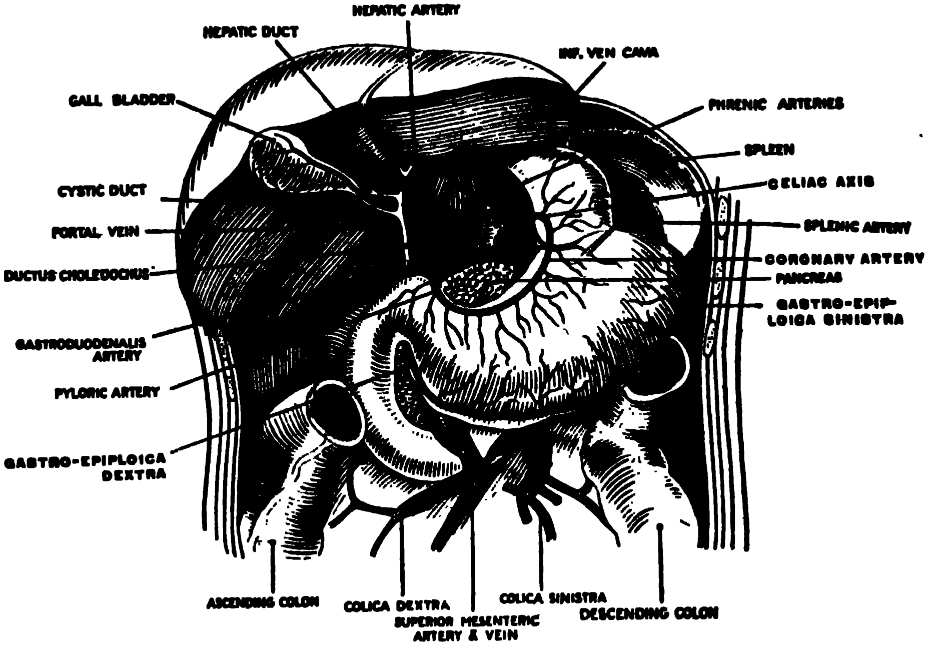


FIG. 3.—BLOOD-VESSELS AND RELATIONS OF STOMACH. (After Corning.)

THE LYMPHATICS.—The lymphatics of the stomach are of special importance in determining the area to be resected in carcinoma. The stomach wall is rich in freely anastomosing and generally valveless lymphatics, particularly the submucous coat. Obstruction, by carcinoma, of the drainage in one direction, therefore, allows easy extension in another along the submucous layer, In the consideration of the direction of the drainage of the lymphatics, the stomach may be divided into 3 areas with their corresponding groups of lymphatic glands which are located along the course of the vessels in the greater and lesser curvatures and about the pylorus (Fig. 4). In the first area, the pyloric region, lesser curvature and ⅔ of the stomach below it, the lymphatics run from right to left and empty into the coronary chain of glands which is located along the whole course of the coronary artery on the lessor curvature. This chain of glands is usually the earliest and most extensively involved in carcinoma of the pylorus. In the second area, which includes about ⅓ of the stomach along the greater curvature, corresponding to the distribution of the gastro-epiploica dextra, the lymphatics run from left to right and drain into a group of glands along that artery. The lymph glands near the pylorus are numerous and close together; further along the greater curvature they are less frequent. The third area of the stomach, the cardia and cardiac end of the great curvature, has a separate group of lymphatics and has been called by Moynihan the "isolated area." Its lymphatics follow the course of the gastro-epiploica sinistra and are not involved in the spread of pyloric cancer.

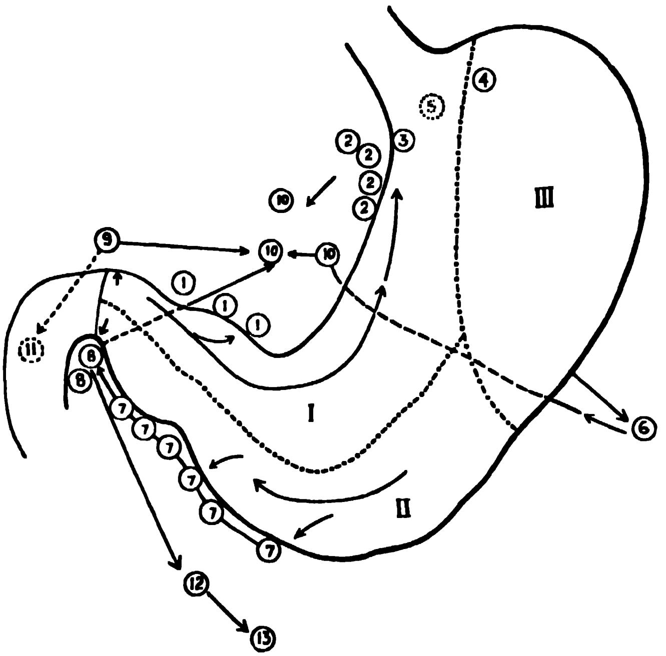


FIG. 4.—DIAGRAM SHOWING DIRECTION OF LYMPHATIC DRAINAGE FROM STOMACH INTO PRIMARY AND SECONDARY GROUPS OF LYMPHATIC GLANDS. 1, Lower coronary; 2, upper coronary; 3, right paracardial; 4, left paracardial; 5, posterior paracardial; 6, splenic; 7, right gastro-epiploic; 8, subpyloric; 9, suprapyloric; 10, suprapancreatic; 11, biliary; 12, superior mesenteric; 13, lumbar.

It is to be remembered, also, as shown by the work of Jamieson and Dobson (17) that there are groups of glands which form a secondary drainage to the primary gland groups. Jamieson and Dobson divided the lymphatic glands of the stomach into 10 main groups: (1) Lower coronary and (2) upper coronary, draining the area along the lesser curvature; (3) right paracardial, (4) left paracardial, and (5) posterior paracardial, situated about the cardiac orifice and draining the fundus; (6) splenic, situated at the hilum of the spleen just above the tail of the pancreas, draining the left part of the greater curvature, and in turn draining secondarily into the left suprapancreatic and from this group into the middle suprapancreatic; (7) right gastro-epiploic, along the artery of the same name, draining secondarily into the (8) subpyloric, which in turn drains into the superior mesenteric and middle suprapancreatic; (9) suprapyloric, draining into the (10) suprapancreatic, which is situated about the celiac axis, and which receives, as shown, tributaries from numerous primary groups and in turn may allow extension to the following secondary groups; (11) biliary; (12) superior mesenteric, and (13) lumbar. The importance and relation of this lymphatic distribution will be further discussed in the consideration of the operation for gastric carcinoma.

PERITONEAL RELATIONS.- The lesser curvature of the stomach has attached to it the lesser or gastrohepatic omentum, the greater curvature, the greater or gastrocolic omentum. The anterior wall is in relation to the greater sac of the peritoneum, the posterior wall to the lesser sac, the opening between the 2 sacs being through the foramen of Winslow, the anterior edge of which contains the hepatic artery, portal vein, and common bile duct. The lesser sac is separated from the greater, below, by the transverse mesocolon, which must be broken through to perform posterior gastrojejunostomy. The relations to the lesser sac are also of importance in the treatment of ulcers or injuries of the posterior stomach wall.

In the performance of gastrojejunostomy the relations of the first portion of the jejunum must be understood. The duodenum, after passing downward and to the left retroperitoneally, being in relation only on its anterior surface to the peritoneum, passes behind the origin of the transverse mesocolon, where it becomes jejunum and is completely invested with peritoneum. This point is 1 in. to the left of the median line and 1½ in., above the umbilicus, lying just to the left of the second lumbar vertebra. From the beginning of the jejunum there is a fold of peritoneum, the ligament of Treitz, passing upward to the mesocolon. Sometimes this fold extends some distance along the jejunum and must be divided in order to avoid having too long a jejunal loop in performing posterior gastrojejunostomy.

Instruments Required.—In addition to the usual laparotomy instruments—knife, scissors (straight and curved), artery clamps, Kocher clamps, thumb forceps (plain and mouse-tooth), retractors (large and small), sponge forceps, aneurysm needle and needle holders—in cases of resection or gastroenterostomy there will be required a gastroenterostomy clamp, the variety known as the Roosevelt clamp being the most useful, or long clamps of the Moynihan or Kocher variety, the blades covered with rubber tubing. For resection, the large clamps of the Kocher, Scudder, or Moynihan variety are employed in division of the stomach, or a crushing clamp of the Payr variety may be used (Fig. 5). There will also be needed curved and straight abdominal clamps which meet at the tip and clamp loosely (having flexible blades) or tightly along the blades, some of which may be covered with rubber tubing and some not. Besides the needles required for suture of the abdominal wall, there will be needed straight and curved intestinal needles. The best material for suture of the stomach wall is 0 chromicized (10-day) catgut and fine Pagenstecher celluloid linen thread. A sufficient supply of sterilized large and small abdominal tail pads made of gauze, folded and sewn so the edges do not fray, with an artery clamp or large safety-pin attached to the ends of each tail, must be provided to wall off all the rest of the abdominal cavity from the part directly operated on. In operations in which the cavity of the stomach is opened, the instruments and needles used in cutting, handling, and suturing the mucous membrane must be discarded as soon as the opening in the mucous membrane is closed; therefore, a duplicate supply of these instruments must be provided.

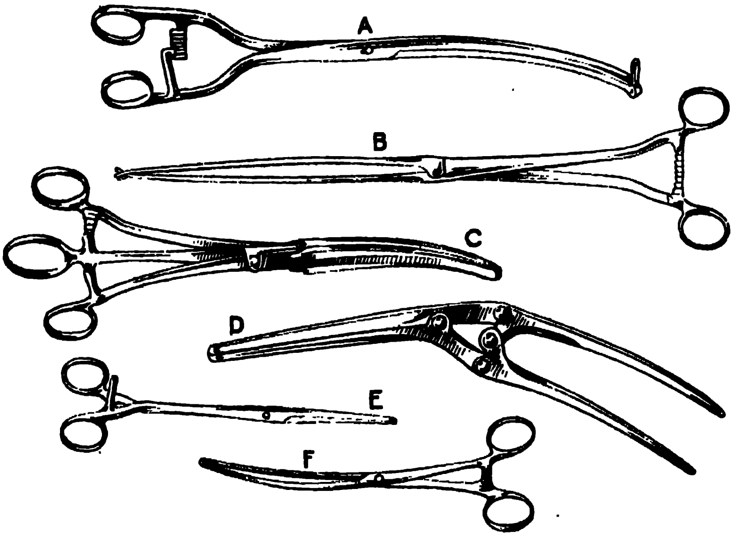


FIG. 5.—SPECIAL INSTRUMENTS USED IN STOMACH OPERATIONS. A, Kocher gastrectomy clamp; B, Moynihan gastrectomy clamp; C, Roosevelt gastro-enterostomy clamp; D, Payr crushing clamp; E, abdominal clamp for clamping proximal end of duodenum in performing pylorectomy; F, Kocher intestinal clamp for anterior or Roux's gastro-enterostomy and clamping distal end of severed duodenum in pylorectomy.

Special Preparation of the Patient for Operation on the Stomach.—Perforation of a gastric or duodenal ulcer, or wounds of the stomach requiring immediate operation, preclude the possibility of any special preparation. In other cases, however, careful preparation of the patient is an element of great importance in the success of the operative procedure. In addition to the general preparation of any patient, catharsis, emptying the intestine by enemata, preparation of the wound area, etc. (Vol. I, Chap. IV), special preparation is required in stomach operations depending on the lesion for which the operation is to be performed and the condition of the patient.

The normal stomach contains few pathogenic organisms, but the dilated stomach resulting from pyloric stenosis due to any cause, or the stomach containing a chronic ulcer or carcinoma, frequently contains many. Efforts must, therefore, be directed to the reduction of this element of infection, first by means of oral antisepsis. Several days before operation the teeth should be brushed gently 3 times a day and an antiseptic mouth wash given. If any pyorrhea alveolaris is present, diluted iodin in alcohol may be used to paint the gums once daily. These precautions not only lessen the number of organisms in the stomach from the saliva swallowed, but also diminish the chances of post-operative pneumonia or parotitis.

If there is no retention of food in the stomach beyond 6 hours, the patient can be fed on sterile liquid food—broths, boiled milk, and boiled water—up to 12 hours before the operation, but no solid food should be given for 24 hours before the operation. A lavage should be given 24 hours before and one just preceding operation, care being taken to empty the stomach. If there is marked stenosis of the pylorus, no solid food should be given for 48 hours before operation, and repeated lavage should give assurance that the stomach is empty. Individual judgment must be exercised in the preparation of each case, as some patients are already in a weakened condition from starvation due to the stenosis, and so little food, even liquid, passes the pylorus that efforts to increase their strength before operation are futile. Others stand lavage badly and are weakened by it.

Retention may last for 72 hours or longer, and I have seen a case in which the bismuth administered for radiography, 48 hours or more before the operation, was still retained at the time of operation, due to difficulty in washing out the stomach because the stomach tube repeatedly became obstructed by raisins, which had also been given 48 hours previously to determine the retention. Such conditions must be considered and guarded against. In a starved and dehydrated patient it is advisable to give water by rectum or saline by hyperdermoclysis for 24 hours preceding operation.

INJURIES TO THE STOMACH: GUNSHOT AND STAB WOUNDS

Perforating wounds of the stomach call for immediate operation as soon as the diagnosis is made or the probability of the existence of a perforation is apparent. Delay for the lessening of primary shock increases the danger from continuing hemorrhage and from leaking, with its resultant peritonitis. Operation statistics, as in all perforations of any hollow abdominal viscus, show a mortality directly increasing with the time that operative treatment is delayed. Small wounds of the empty stomach may cause little leaking of the stomach contents because the rent becomes partly closed by protrusion of the mucous membrane. Vomiting increases leakage by squeezing the stomach contents out of the rent. Injuries of the posterior stomach wall, perforation of the neighboring viscera, and hemorrhage from the larger blood-vessels of the stomach must be considered, and if the direction of the perforation indicates this possibility, sought for and treated.

Technic of Operation.—If the patient is in shock, the operation may best be performed, or at least begun, under local anesthesia with ½ per cent. novocain, preceded by a hypodermic of ⅛ to ¼ gr. morphin sulphate and 1/100 gr. atropin sulphate, the local anesthesia to be supplemented by a general anesthetic if extensive exploration is necessary, general peritonitis is present, or the patient cannot be reassured and kept quiet so as to allow careful and rapid work. Vomiting must be avoided and, therefore, gas and oxygen anesthesia or chloroform carefully administered has an advantage over ether.

After sterilization of the skin of the whole abdominal and lower chest wall with iodin, an incision 4 in. (10 cm.) long is made in the median line. The median line is chosen because the incision can be rapidly extended upward or downward as indications warrant, or more room obtained if necessary, as is rarely the case, by transverse division of the left rectus muscle. On reaching the peritoneum, dark blood may be seen behind it if there has been considerable hemorrhage. On opening the peritoneum, which should be lifted up by 2 pairs of plain thumb forceps and nicked with the knife or scissors and then carefully divided in the line of the abdominal incision as it is held up and away from the abdominal contents, it should be observed whether there is an escape of gas, blood, or stomach contents from the peritoneal cavity. If there is fluid present, the tube of a suction apparatus, if one is provided, should be immediately introduced to remove all fluid possible with the least disturbance of the stomach. In the absence of a suction apparatus, the fluid should be gently but rapidly wiped out with stick sponges. It is of advantage at this point to elevate the head end of the table to allow the intestines to fall away from the incision and the epigastric area, and so permit of more room for examination and the necessary manipulation and insertion of pads. Carefully insert laparotomy pads to wall off the involved area from the rest of the peritoneal cavity. Examine the anterior stomach wall where the wound of entrance makes the lesion most probable. Remember that gentle handling of the stomach is essential, as otherwise the contents may be squeezed out, particularly through an invisible wound on the posterior wall.

On locating the wound in the anterior wall of the stomach, it should be immediately sutured. Usually the wound does not require any trimming of the edges. Two layers of sutures should be employed. The first layer of through-and-through sutures should be of 0 chromic catgut and include all the layers of the stomach wall. The second layer, inserted after the first has been tied, a Lembert suture of fine Pagenstecher linen thread including the serous and muscular layers, inverts the first row. If the wound is small, a double row of purse-string sutures may be employed. A large wound on the anterior wall may make possible the search for an injury to the posterior wall, but usually the injury on the anterior wall should be closed immediately and examination of the posterior wall made through an incision in the gastrocolic omentum. In dividing this structure, while the branches of the gastro-epiploic vessels may be ligated, care must be taken to avoid injury or tearing of the branches of the colica media, dextra and sinistra. Damage to other organs should be sought for and repaired if present.

After careful attention to the toilet of the peritoneum, depending on the condition present, the amount of leakage or the presence of a general peritonitis, the wound is closed with layer sutures reinforced by 3 or 4 through-and-through silkworm-gut sutures.

Drainage.—If there has been a considerable escape of stomach contents into the peritoneal cavity, irrigation may be necessary, but usually, by suction and sponging, this can be avoided. After a small stab wound of the anterior stomach wall, the abdominal wound can usually be closed without drainage. After bullet wounds, when the bullet may have carried a portion of the clothing with it, and in cases where the posterior stomach wall has been injured and the lesser sac infected, a folded rubber dam drain should be inserted in the lesser sac and pass out through an opening in the gastrocolic or gastrohepatic omentum and the abdominal wound. Extensive drainage should, as a rule, be avoided, but if operation has been delayed until general peritonitis has developed from severe and widespread contamination of the whole peritoneal cavity, a folded rubber dam drain should be introduced into the pelvis through a separate small stab incision low down in the median line, and the patient should be placed in the Fowler position.

After-treatment.—After operation large amounts of fluid should be administered by rectum or hypodermoclysis. Water should not be given by mouth for 12 hours, and then in small amounts. If peritonitis is present, all food by mouth should be withheld and the Ochsner treatment followed.

Complications, Difficulties and Results.—Rarely the repair of an injury in the neighborhood of the pylorus may occlude the pyloric opening to such an extent that a gastrojejunostomy or pyloroplasty is necessary. The results of the operation depend on so many other factors, such as the amount of hemorrhage, damage to other viscera, the amount of leakage, whether the stomach was distended with food or empty, and delay in the operation, that statistics are of little value.

REMOVAL OF FOREIGN BODY FROM THE STOMACH: GASTROTOMY

Indications.—As a rule, foreign bodies which pass through the esophagus and cardiac orifice into the stomach are passed on by that organ through the pylorus. I have seen an irregular, sharp-pointed tooth plate which had been swallowed passed by rectum after 72 hours; and on another occasion I removed from the ascending colon the broken-off sharp-pointed bone handle of a tooth brush 9 cm. long, which radiography showed to be located in the stomach 12 days after it had been swallowed and which had passed from the stomach to the ascending colon in the 24 hours immediately preceding the operation. Occasionally a sharp article swallowed by children or the insane, or by accident, such as a tooth plate, open safety-pin, a hair ball, etc., may require removal.

Technic of Operation.—A vertical incision 4 in. (10 cm.) long is made ¾ in. (1½ cm.) to the left of the median line in the epigastric region through the anterior sheath of the rectus muscle. Attach wash cloths to the edge of the skin incision with clamps, thus avoiding contamination from the skin, displace the rectus muscle outward from the median line, incise the posterior layer of the rectus sheath and peritoneum directly behind the incision in the anterior sheath, locate the foreign body and determine the situation and size of the opening in the stomach necessary to remove it without stretching, tearing, or injury of the stomach wall. Insert laparotomy pads to wall off all of the peritoneal cavity from the part of stomach wall exposed for operation. The incision should be made vertical to the long axis of the stomach and therefore parallel to, and so avoiding cutting the branches in the stomach wall from the vessels of the greater or lesser curvature. If a large exploratory wound in the stomach is necessary, it may be made originally in a horizontal direction.

Having determined the length and location of the incision, insert a linen traction suture through the seromuscular layers of the stomach wall just beyond each end of the proposed incision. Make traction on these sutures, lifting up the line of incision (2 volsellæ may be used instead of traction sutures for this purpose). Employ a second layer of laparotomy pads on each side and about the line of incision. Incise the stomach and remove the foreign body with forceps. Insert a row of through-and-through continuous sutures of 0 10-day chromic catgut, pulling each stitch tight to check hemorrhage and inverting the edges so that no mucous membrane protrudes. Discard instruments, needles, etc., that have touched the mucous membrane, change gloves, remove the outer layer of laparotomy pads that have been contaminated and arrange fresh pads. Insert a row of continuous fine Pagenstecher linen Lembert sutures. Remove pads and close the abdominal wound by layer suture. Administer water by rectum, but withhold it by mouth for 12 hours. Withhold food by mouth for 24 to 48 hours, depending upon the size of the wound in the stomach, the presence of vomiting, and the need of nourishment of the patient.

There is little difficulty or danger in this operation. Care of details avoids infection of the peritoneum and careful proper suture of the wound in the stomach prevents leaking or hemorrhage.

ULCER OF THE STOMACH

Indications for Operation.—Chronic ulcer of the stomach or duodenum which does not respond to medical treatment, or recurs after such treatment, requires operation for its cure. The association of retention, with the symptoms of chronic ulcer, indicates operative procedure. The danger of perforation, the possibility of malignant degeneration, and the far better statistics of operative than of medical treatment are additional arguments in favor of the surgical treatment of chronic ulcer. According to Wilson and McCarty (45), 71 per cent. of 153 cases of undoubted gastric carcinoma presented gross and microscopic evidence of previous ulcer. This view of the danger of malignant degeneration of chronic ulcer is concurred in by Payr and Küttner, but is denied by Grüber (14) and Paterson (30).

Acute ulcer of the stomach is a medical condition and does not require operation. Also, as a rule, hemorrhage from the stomach is better treated by medical than surgical means. In the presence of repeated hemorrhage, however, operation is indicated. Perforation of an ulcer of the stomach or duodenum is an immediate indication for operation. Stenosis of the pylorus or the various forms of hour-glass stomach, caused by healed ulcers, can only be cured by surgical means.

Methods and Choice of Treatment of Chronic Ulcer of the Stomach or Duodenum.—The methods of surgical treatment are (1) gastrojejunostomy, either alone or combined with excision, infolding of the ulcer, or occlusion of the pylorus; (2) excision of the ulcer; (3) resection of the pylorus (Rodman).

Smithies (39), in an analysis of 1,341 operations for ulcer of the stomach and duodenum in the Mayo Clinic, states that 80 per cent. of the gastric ulcers were in the pyloric half of the stomach and 40 per cent. at the pylorus. Also, according to figures from the Mayo Clinic, duodenal ulcers are more frequent than gastric. In 1,000 cases 57 per cent. were duodenal and 43 per cent. were gastric.

Because of this situation of the ulcer, the operation most frequently done is gastrojejunostomy, its purpose being to empty the stomach by a new opening and thus allow the ulcer to heal by relieving it of the traumatism caused by food passing over it. Also, the influence of the bile and alkaline intestinal secretion lowers the acidity of the stomach contents and promotes healing.

GASTROJEJUNOSTOMY

In performing a gastrojejunostomy the anastomosis may be made to the posterior wall of the stomach—posterior gastrojejunostomy, originated by Von Hacker and developed and modified by Moynihan and Mayo—or to the anterior stomach wall as originated by Woolfler, and modified by Kocher. Depending on the length of the loop of jejunum employed, the term "short-loop" or "no-loop" gastrojejunostomy is used.

Choice of Operation.—The most commonly approved gastrojejunostomy is the posterior no-loop operation, as it is agreed by most surgeons that better drainage is afforded and the complications of "vicious circle" peptic ulcer and internal hernia are less liable to occur after this procedure. When, however, the posterior wall of the stomach is adherent to the pancreas or involved in the ulcerating or carcinomatous process, a posterior gastrojejunostomy is impossible, and the anterior operation must be chosen if a gastrojejunostomy is to be done. Anterior gastrojejunostomy is, however, considered by some the operation of choice, as by Kocher, who states that it gives good results, is more easily performed, causes less adhesions, and, if a secondary operation has to be done, as for peptic ulcer, is more easily located.

Posterior No-loop Gastrojejunostomy.—STEP 1.—Make a vertical incision 4 in. (10 cm.) long, ¾ in. (1.5 cm.) to the right of the median line through the skin and anterior sheath of the right rectus muscle. Fasten wash cloths with clamps to the edges of the skin incision on both sides to protect the abdominal viscera from any contact with the skin. Displace the rectus muscle outward along the whole length of the incision; incise the posterior rectus sheath and peritoneum in the line of the skin incision. Examine first the gall-bladder as a routine procedure, then the whole stomach and pylorus to insure the fact that the diagnosis is correct and that other complications, such as multiple ulceration or hour-glass stomach, have not been overlooked.

STEP 2.—Lift up the transverse colon and mesocolon from the wound. Place abdominal tail pads, wrung out thoroughly from hot saline, below the colon, separating all of the small intestines and the abdominal cavity below the operative area from that above. A second layer of pads should be placed above the first so that, if any contamination does occur, these latter can be removed and replaced without disturbing the first layer. Lift up the colon, thus putting the mesocolon on the stretch; make a small nick with scissors in the mesocolon near and above the portion where the jejunum begins, choosing a place where no blood-vessels show through. Enlarge the opening to about 3 in. (7 cm.) by stretching with scissors, thus entering the lesser sac. Avoid injury to the vessels in the mesocolon, but if this occurs, tie the bleeding point at once. Push the posterior wall and greater curvature of the stomach through the opening with the fingers of the left hand, grasping the posterior wall with the right hand and pulling through enough to be easily grasped with a clamp. Apply the upper part of a 3-bladed clamp to the posterior wall of the stomach, including the area which is to be the site of anastomosis. This should be so arranged that the opening reaches to the greater curvature below and is as near as possible to the pyloric end of the stomach as the circumstances indicating the operation will allow, usually at the junction of the vertical with the pyloric horizontal portion of the stomach. The tip of the clamp points toward the patient's left shoulder. Three inches (7 cm.) of the stomach wall should be included in the clamp. Pull upon the mesocolon and locate the jejunum as it emerges from under the mesocolon to the left of median line. Divide the ligament of Treitz, if present, from the first portion of the jejunum (Fig. 6). Pull forward the upper part of the jejunum from its origin and hold it up while the colon, mesocolon, and all the rest of the stomach not held in the clamp are replaced. Cover the replaced viscera with laparotomy pads, turn the clamp so that it becomes horizontal, with the tip toward the left side, and place a narrow pad or gauze strip along the side of the area of the stomach caught in the upper part of the clamp and parallel with its long axis. Attach the other blade of the clamp and pull through a portion of the jejunum between the blades of the clamp so that the area in the grasp of the clamp equals the length of the clamped stomach area, leaving no loop proximal to the point of anastomosis and with the tip of the clamp distal to it. Thus the direction of the intestine is from right to left (Fig. 7).

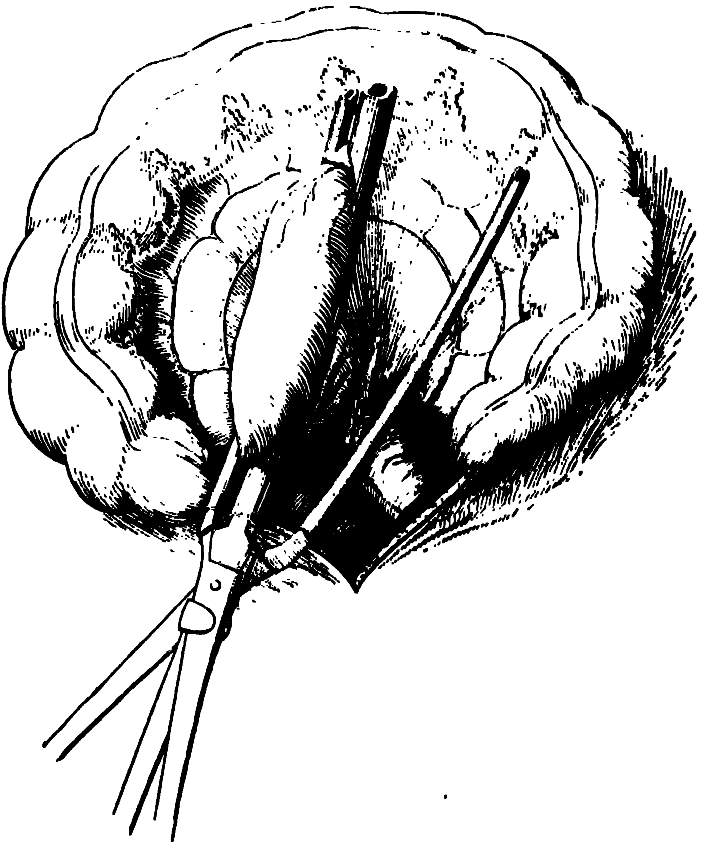


FIG. 6.—POSTERIOR GASTROJEJUNOSTOMY. Posterior stomach wall pulled through opening in mesocolon and grasped in upper part of Roosevelt clamp. Ligament of Treits separated from beginning of jejunum.

STEP 3.—Begin the first layer of sutures. With fine Pagenstecher linen thread on a curved intestinal needle, start the seromuscular sutures at the end nearest the assistant (tip of clamp), and continue to the other end of the area (handle of clamp), uniting the serous coats of the stomach and intestine for a distance of 2½ in. (6.25 cm.). Make a lock stitch at the end of this suture and leave the end long with needle attached.

STEP 4.—On each side of the suture line, parallel to it and ¼ in. (.625 cm.) from it, with a knife make an incision of equal length through the seromuscular coat of the stomach and intestine down to but not through the mucous membrane, the incision being ¼ in. (.625 cm.) shorter at each end than the first suture line. Excise the ellipse of mucous membrane exposed by retraction after incision in the seromuscular coat.

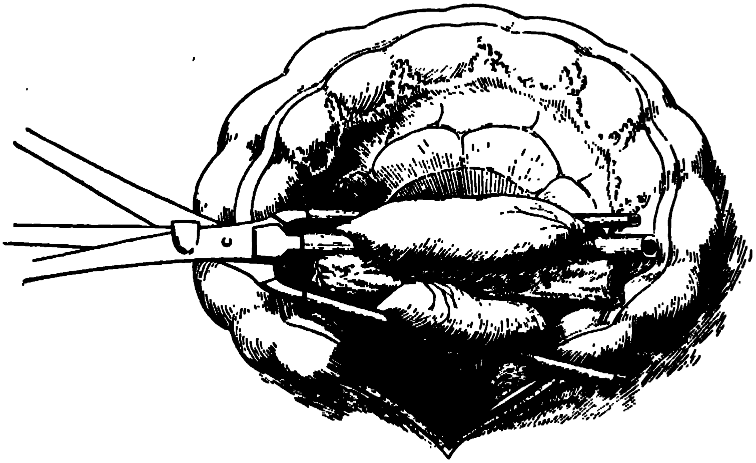


FIG. 7.—POSTERIOR GASTROJEJUNOSTOMY. Clamp turned in horizontal direction. Gauze strip in place. Jejunum pulled up ready to clamp parallel and in opposition to stomach wall.

STEP 5.—Grasp in an Allis clamp the lower angle of both incisions, holding them together, serosa to serosa, and preventing retraction of the mucous membrane. Let the clamp hang down, making tension. Insert a second or deep layer of sutures. This is a suture passing through all 3 coats, each stitch pulled tight for hemostasis, aiming at careful apposition and inversion of the walls to bring the peritoneal coats in contact. Start the suture at the end of the opening toward the tip of the clamp. Begin with the needle in the lumen of the

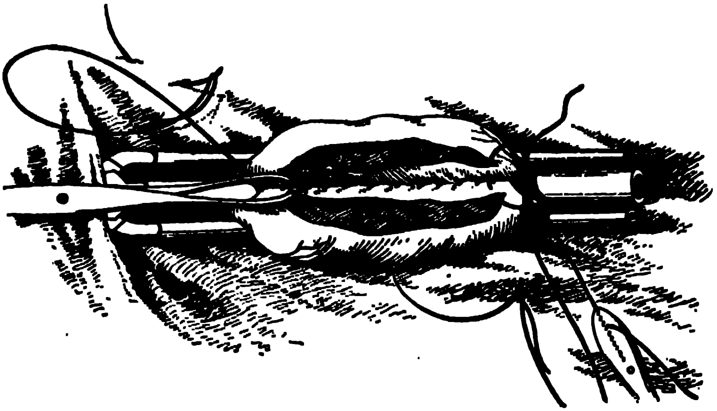


FIG. 8.—POSTERIOR GASTROJEJUNOSTOMY. Posterior serous suture of linen thread inserted. Stomach and intestinal wall divided on each side of suture line. Beginning of inner suture with catgut.

intestine, pass it through the intestinal wall, then the stomach wall, and tie the first knot so that it is inside of the opening (Fig. 8). Continue with an over-and-over stitch, including all coats of both stomach and intestine, thus bringing ¼ in. (.625 cm.) of the serosa of each in contact along the posterior wall of the gastrojejunostomy opening until the end of the incision is reached. The suture is now continued along the anterior wall. It may be continued in a similar manner, but it is of advantage to change, just before turning the corner, to the Connell stitch, with the loop in the lumen of the opening; that is, where the change of stitch occurs, beginning in the lumen on the intestinal side, the

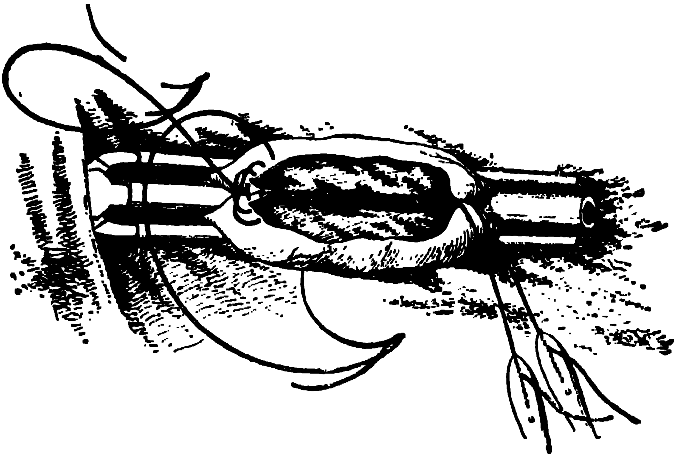


FIG. 9.—POSTERIOR GASTROJEJUNOSTOMY. Posterior suture line completed. Change from "over-and-over" suture to "loop on the mucosa" on reaching corner to continue suture on anterior wall of anastomosis.

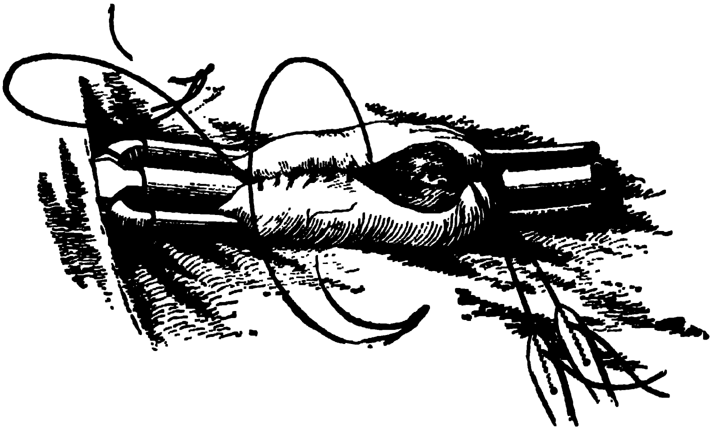


FIG. 10.—POSTERIOR GASTROJEJUNOSTOMY. Suture of anterior wall by "loop on the mucosa" stitch of catgut inverting edges and bringing serosa of stomach and jejunum in apposition.

needle passes out of the lumen ¼ in. (.625 cm.) from the point of entrance through the intestinal wall to the serosa, over both edges, through the stomach wall from the serosa to the mucosa, through the stomach wall again, ¼ in. (.625 cm.) from point of entrance, from mucosa to serosa, over both edges, entering the intestine from serosa to mucosa (Fig. 9). This stitch is continued to the end of the opening, where it is tied to the knot where this deep suture began (Fig. 10). Thus the knot is on the inside and there is a good inversion of the mucous layer and excellent apposition of the serosa. Change gloves and lay aside all sutures and instruments that have touched the mucous membrane.

STEP 6.—Loosen the clamp on both sides; see if any bleeding occurs. If so, it may be stopped with an extra stitch. Pick up the needle which has been laid aside, carrying the first suture of Pagenstecher through the peritoneal coat, and continue the Lembert suture over the anterior through-and-through suture line, to just 1 stitch beyond where the first stitch was started (Fig. 11). Tie to the end left long when the first knot was tied. Remove the middle bar of the clamp. Pull laterally first to one side then the other the layer of gauze behind the new gastrojejunostomy opening, thus exposing the whole line of suture for inspection.

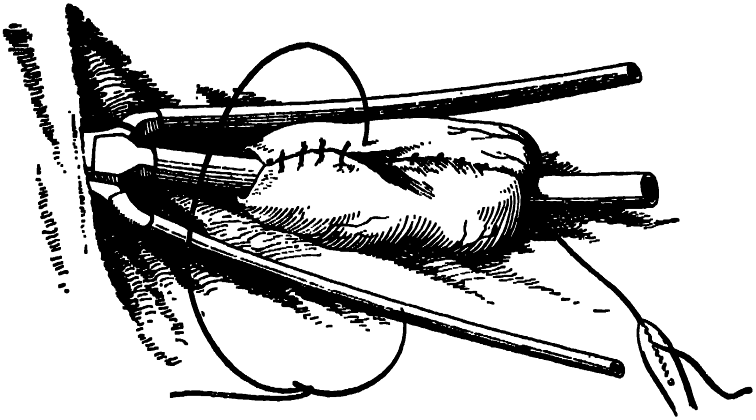


FIG. 11.—POSTERIOR GASTROJEJUNOSTOMY. Inner suture of catgut completed and tied. Clamp loosened. Continuation of outer Lembert suture of anterior wall.

STEP 7.—Return the posterior stomach wall through the opening in the mesocolon. Suture with 4 or 5 interrupted catgut sutures the edges of the rent in the mesocolon to the margin of the gastrojejunostomy stoma, inserting the suture so that the edge of the rent in the mesocolon is turned in toward the lesser sac, and the margin of the gastrojejunostomy suture line is covered by the surface of the mesocolon. This prevents the possibility of hernia of the small intestine through the opening in the mesocolon and aids in the closing of the suture line where there might be some possibility of leakage into the greater peritoneal cavity. (Patterson sutures the mesocolon to the stomach wall instead of to the line of anastomosis.) Remove all pads and close abdominal wound with layer suture without drainage.

MODIFICATIONS.—The above description is that of the operation performed with slight modification by the majority of American surgeons. The direction of the loop of jejunum is from right to left. The desirability of this modification of the original method was first called attention to by Mayo, who showed that the natural direction of the first portion of the jejunum was downward and to the left, and that the turning of the jejunum to the right in performing the anastomosis with the stomach tended to the production of a kinking above the anastomosis and, therefore, increased the danger of vicious circle (Fig. 12). Moynihan, however, with his great experience in this operation, still adheres to his original method of turning the jejunum to the right, in order to obtain an isoperistaltic anastomosis, and he denies that vicious circle or kinking is any more apt to occur with this procedure.

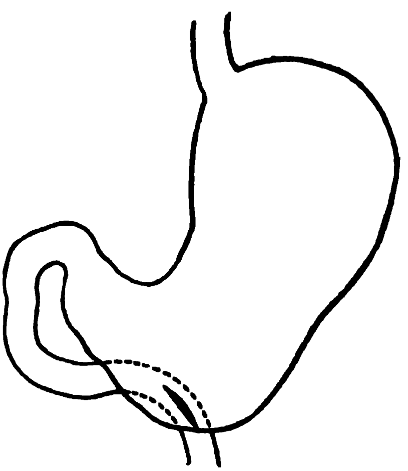


FIG. 12.—POSTERIOR GASTRO-ENTEROSTOMY. Diagram showing position and direction of opening and direction of intestine after antiperistaltic anastomosis.

Mayo has also made a slight modification of his method in this operation within the past few years, returning to the old method of applying 3 rows of sutures posteriorly in place of the 2 usually employed, in order to diminish the chance of hemorrhage. After the serous layer has been inserted and the intestinal and stomach wall has been cut through the serous and muscular coats, to but not through the mucous membrane, a second layer of sutures unites the divided edges, picking up at the same time a small bit of the mucous membrane. The third row unites the mucous membrane edges, the mucous membrane being divided after the second row of sutures has been inserted.

There is also some difference of opinion as to the best direction of applying the clamp to the stomach wall. As a rule, the clamp is applied vertically, as is done by Kocher and Moynihan but, from an examination of the results of a large number of operations by different surgeons, this detail appears to be of no great importance. A number of surgeons perform gastrojejunostomy without the use of clamps, in order to lessen the chance of postoperative hemorrhage. In infants with pyloric stenosis the operation is necessarily done without clamps.

Roux's Gastrojejunostomy "en Y."—In order to avoid vicious circle after gastrojejunostomy, which was more frequent when a long jejunal loop was employed than now when the operation above described is done, Roux devised the following operation;

The incision, opening of the mesocolon, and isolation and clamping of the area near the greater curvature of stomach are carried out as in the previous operation. Pull up a loop of jejunum about 8 in. (20 cm.) long, the center of which is about 10 in. (25 cm.) from the beginning of the jejunum. Empty the loop of intestinal contents and clamp with a rubber-covered clamp. Carefully apply pads. Divide the intestine straight across, 2 in. distal to the upper clamped extremity. Cut into the mesentery in the line of division of the jejunum sufficiently to allow mobilization of the divided ends. By 2 layers of suture, 1 peritoneal and 1 through all the layers of the intestine and stomach, anastomose the distal end of the divided jejunum into the stomach area held in the clamp. This anastomosis may be made to either the anterior or posterior stomach wall. The line of incision in the stomach should equal the diameter of the intestine. Implant the proximal divided end into the side of the jejunum 3 in. (7.5 cm.) below the site of the anastomosis of the distal end to the stomach. The incision in the lateral wall of the intestine where anastomosis is made is vertical and equal in length to the diameter of the intestine. Sutures are inserted as in the previous method. Suture the opening in the omentum to the gastrojejunostomy site and close the wound (Fig. 13).

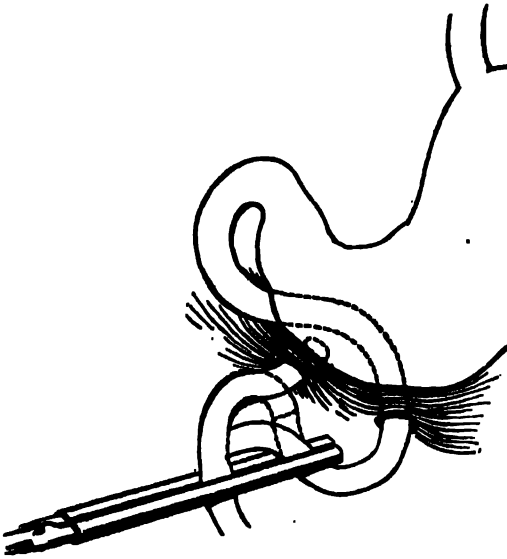


Fig. 13.—Roux's Gastrojejunostomy en Y Diagram. Distal limb united to stomach, proximal limb united to jejunum below gastrojejunostomy.

Anterior Gastrojejunostomy: Woolfler's Method.—Make an incision 4 to 5 in. (10 to 12 cm.) long in the epigastric region, ¾ in. (1.5 cm.) to the right of the median line, displace the rectus outward, open the peritoneum, and examine the stomach thoroughly. Pull up the mesocolon and colon and locate the beginning of the jejunum as described above. Pull up and isolate a loop of jejunum about 18 in. (45 cm.) long, always keeping in mind which is the distal and which the proximal end of the loop. Empty the loop of intestinal contents and apply the lower limb of a gastrojejunostomy clamp to an area of about 3 in. (7.5 cm.) of the apex of the loop. The tip of the clamp should point toward the distal end of the loop. This clamped area is now brought up over the colon until it is in apposition with the lowermost point of the anterior wall at the greater curvature of the stomach. Attach the upper limb of the gastrojejunostomy clamp and pull into the grasp of the clamp an area of stomach 3 in. (7.5 cm.) long to be anastomosed; the direction of the clamp and, therefore, of the line of anastomosis should be downward and to the right. Be sure that the proximal limb of the jejunum will not constrict the transverse colon. Bring the clamped-off areas out of the abdominal wound and apply pads shutting off all the rest of the abdominal cavity. Perform anastomosis exactly as described under posterior gastrojejunostomy, except that the outer layer or peritoneal suture is slightly longer, while the incision in the stomach and intestinal wall and, therefore, the internal suture are shorter. This aims to prevent kinking of the jejunal loop at the point of anastomosis. As an additional means of preventing kinking, 1 or 2 fine catgut sutures attach the intestinal loop to the stomach wall in the line of and above and below the gastrojejunostomy, thus suspending the intestine above the gastrojejunostomy opening. It is further to be noted that the incision in the intestine should be made somewhat posteriorly to the line opposite the mesentery, so that the jejunum shall be flat against the stomach wall after the viscera are returned to the abdominal cavity (Fig. 14).

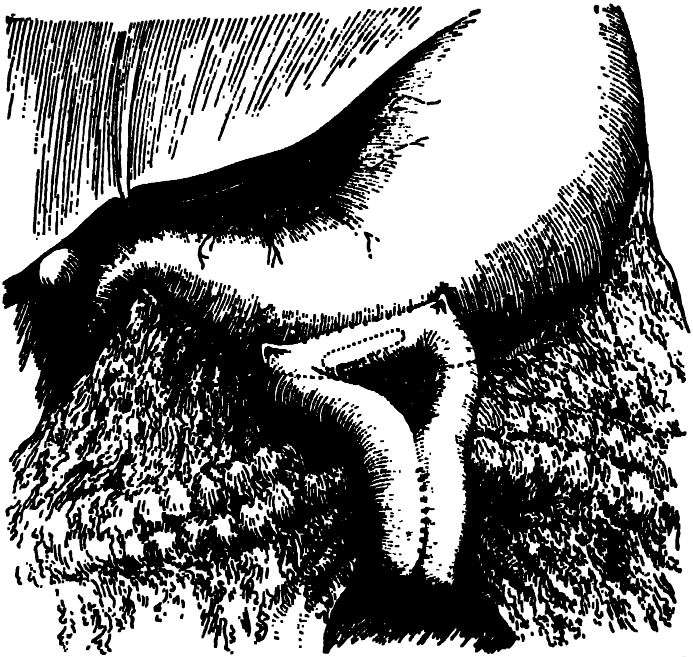


Fig. 14.—Anterior Gastrojejunostomy. Loop of jejunum fastened by mattress stitch beyond anastomosis at each end to prevent kinking. Entero-anastomosis by suture.

After anterior gastrojejunostomy, vicious circle is particularly apt to occur, and for this reason an entero-enterostomy by lateral anastomosis is usually done about 3 in. (7.5 cm.) below the gastrojejunostomy opening. This may be done by means of a Murphy button or by suture. If suture is employed, the 2 convex surfaces are brought together and the anastomosis made exactly as described in posterior gastrojejunostomy, its purpose being to allow any stomach contents escaping from the pylorus, the hepatic and pancreatic secretions to empty from the proximal into the distal loop without being regurgitated into the stomach.

Anterior Gastrojejunostomy: Kocher's Method.—Kocher's method of anastomosis differs from the preceding in the fact that, after the separation of the gastrocolic omentum from about 2 in. (5 cm.) of the greater curvature, a loop of jejunum 16 in. (40 cm.) long is pulled up, emptied, and clamped off. The point of anastomosis is chosen, and just proximal to this point the wall of the intestine is infolded transversely on its convex surface and sutured with a few Lembert sutures to make a spur. The proximal limb of the jejunum loop at the point infolded is sutured to the stomach just behind the lowest point of the greater curvature, leaving the end of sutures long, the line of suture of the intestine being transverse to the long axis. A curved incision a little less than the breadth of the intestine is made 1/4 in. (.625 cm.) below this suture line through the intestinal wall, and a similar curved incision of the same length is made 1/4 in. (.625 cm.) above the suture line on the stomach wall. The edges of the incisions in the stomach and intestine are united, and the serous layer of suture, inserted posteriorly as a first step, is continued in front. To prevent kinking, the proximal limb must be sutured to the stomach above the point of anastomosis. (Kocher uses 3 layers of sutures, the middle layer being through the serosa and muscular coat.)

Gastrojejunostomy by Other Means than Suture.—When the operator has experience and is able to work rapidly, gastrojejunostomy should be performed by means of suture. If the patient's condition is serious and speed is essential to save life, an anastomosis may be done by the Murphy button, but this adds an element of danger from subsequent leakage and infection, and the opening cannot be made as large as by suture. The methods of anastomosis by the McGraw elastic ligature and the Maury twine suture, both of which aim at a gradual cutting through of an opening between the intestine and stomach by pressure necrosis, while they lessen the danger from prolonged operation and infection as immediate results of operation, introduce the element of uncertainty of accomplishing their purpose and cannot be employed when an immediate opening between the stomach and intestine is desired, as it takes an average of 72 hours to establish the communication.

Complications and Causes of Failure after Gastrojejunostomy.—The complications and causes of failure after gastrojejunostomy are (1) hemorrhage, (2) regurgitant vomiting or vicious circle, (3) peptic ulcer of the jejunum, (4) intestinal obstruction due to internal hernia or other causes, (5) closure of the opening, (6) too rapid emptying of the stomach.

HEMORRHAGE.—This may occur from the ulcer or ulcers, but most frequently the bleeding comes from the line of anastomosis. Gentleness in handling the stomach and infolding of the ulcer by suture aim to prevent postoperative hemorrhage from the ulcer. Care in the application of the deep layer of sutures, seeing that all 3 layers of the stomach and intestinal wall are included in each individual stitch and making sure that each stitch is pulled tight before the needle is again inserted, prevent hemorrhage from the line of anastomosis. In addition to this, on loosening the clamp before inserting the final serous suture, all bleeding from the edges should be stopped by additional sutures if necessary. A few surgeons avoid the use of clamps in the performance of gastrojejunostomy to lessen the danger of hemorrhage.

REGURGITANT VOMITING OR VICIOUS CIRCLE.—Regurgitant vomiting or vicious circle is due to obstruction of the jejunum proximal or distal to, or at the point of anastomosis, caused by kinking or rotation of the jejunum, or by the improper placing of the anastomosis on the stomach wall, so that the stomach contents are emptied into the proximal, instead of into the distal loop. It rarely occurs with the posterior "no-loop" gastrojejunostomy, and for that reason this is the operation of choice. If a loop is left in posterior gastrojejunostomy, kinking and obstruction may occur. Entero-anastomosis below the gastrojejunostomy, division of the proximal loop and implantation of it to the jejunum distal to the gastrojejunostomy opening, as in Roux's operation, the performance of Roux's operation, or occlusion of the pylorus may be performed at the time of the original gastrojejunostomy, especially in anterior gastrojejunostomy, where regurgitant vomiting is apt to occur, or may be done if this complication ensues after a gastrojejunostomy. The vomiting may consist of large quantities of duodenal and jejunal contents, or there may be a constant and frequent regurgitation of bile. If it appears, gastric lavage, administered with care and using small quantities of water at a time, should be practiced. When persistent and not controlled by lavage, one of the before-mentioned operations must be done.

PEPTIC ULCER OF THE JEJUNUM.—Ulceration of the jejunum a few inches below the point of anastomosis or at the margin of the anastomosis may occur either a few weeks or even years after a gastrojejunostomy. In all recorded cases the ulceration has followed gastrojejunostomy for non-malignant disease. Gastrojejunal ulcer may be due to an infected hematoma or a nonabsorbable suture along the line of anastomosis. Jejunal ulcer is probably due to the action of the acid gastric secretion on the jejunal mucosa which normally is bathed by an alkaline secretion, plus infection. In the majority of cases hyperacidity of the gastric juice is present, but not invariably, and Wilkie (43), after animal experiments, concluded that hyperacidity of the gastric contents alone was not sufficient to cause jejunal ulceration. It has been proved that the upper segment of the jejunum is more resistant to the gastric juice than the lower; therefore, the more distant from the stomach the anastomosis is made—that is, the lower down on the jejunum—the greater the liability to jejunal ulceration. Hence its infrequency after the posterior no-loop gastrojejunostomy and its greater frequency with the anterior operation. Because of the diverting of the alkaline duodenal secretion 3 in. (7.5 cm.) below the point of anastomosis in Roux's operation, it follows the latter operation more frequently than any other form of gastrojejunostomy.

Jejunal ulceration is guarded against by performing the posterior no-loop gastrojejunostomy, and prevention of the ulceration which occurs at the margin of the stoma is assisted by careful approximation of the edges of the mucous membrane of the stomach and intestine and by the use of catgut for the deep suture instead of non-absorbable material.

When such ulceration occurs either at the point of anastomosis or in the jejunum, Mayo Robson (34) advises one of the following procedures, depending on the condition found: (I) If the original ulcer at the pylorus or duodenum has healed without stricture, detach the jejunum from the stomach, excise the ulcer and if necessary resect the jejunum, close the opening in the stomach, and restore continuity in the jejunum. (II) If the pyloric or duodenal ulcer has healed, causing stenosis, detach the anastomosis, excise the ulcer or ulcerated segment of the intestine, perform a new gastrojejunostomy either by posterior or by Roux's anterior method, or close the anastomosis and perform Finney's pyloroplasty. (III) If the ulcer is only in the jejunum at a sufficient distance below the line of anastomosis, which is healthy, excise the ulcer or, if necessary, resect the jejunum without interference with anastomosis. (IV) If the patient is in such a desperate condition that he will not bear prolonged operation, perform a jejunostomy and thus give complete rest to the ulcerated area by jejunal feeding.

H. J. Paterson, in cases of recurrent jejunal ulceration, recommends a modification of Roux's operation to divert the alkaline pancreatic and biliary secretion into the stomach to neutralize the acid secretion.

INTESTINAL OBSTRUCTION OR INTERNAL HERNIA.—Hernia of the small intestine into the lesser sac may occur after posterior gastrojejunostomy. It is prevented by suture of the margins of the rent in the mesocolon along the line of suture of the gastrojejunostomy opening. After anterior gastrojejunostomy, obstruction of the transverse colon may occur if the loop of jejunum used for the anastomosis is too short, or the small intestine may pass through the jejunal loop and become obstructed.

CLOSURE OF THE OPENING.—The gastrojejunostomy opening in a few cases has become closed. This has usually occurred after the gastrojejunostomy has been performed by a Murphy button or the stoma is improperly placed, so that the gastric contents continue to pass through a still patent pylorus. To prevent this occurrence, the opening in the stomach should be 2 in. (5 cm.) in length and reach to the greater curvature to insure complete drainage. Moynihan considers the excision of the ellipse of mucous membrane from both stomach and jejunum, as described under posterior gastrojejunostomy, to be of importance in establishing the opening. Many surgeons now perform an occlusion of the pylorus with gastrojejunostomy as, if the new opening does not functionate, its tendency will be to close spontaneously.

TOO RAPID EMPTYING OF THE STOMACH.—Cases have been reported where the relief of the gastric symptoms has not followed gastrojejunostomy and the X-ray has demonstrated too rapid emptying of the stomach. This sequel would appear to be less likely to occur if the stoma is made as near the pyloric end of the stomach as the pathological condition allows, and at the same time thorough drainage not interfered with. Too large an opening should also be avoided.

EXCISION OF GASTRIC ULCER

The influence of gastrojejunostomy upon the establishment of a cure of pyloric and duodenal ulcers has been demonstrated. Chronic ulcers of the lesser curvature at some distance from the pylorus, the so-called saddle-shaped ulcers, and ulcers of the posterior wall of the stomach are frequently not benefited by this form of treatment and should, therefore, when possible, be excised. When the ulcer is close to the cardia or is adherent posteriorly to the pancreas or above to the liver, the operation may be extremely difficult. In one case I found that a large callous ulcer of the lesser curvature had perforated, the perforation becoming closed by adhesion to the liver, so that it was easier to excise a wedge-shaped portion of the liver with the ulcer rather than to attempt a separation. This case was of special interest as a demonstration of the importance of excision, as, although the patient was only 30 years of age, microscopical examination of the specimen showed the presence of carcinoma. The operation was done a year and a half ago and the patient is in good health with no signs of recurrence. If the ulcer is of the anterior wall, its excision or infolding presents little difficulty; therefore, only excision of those on the lesser curvature and of the posterior wall will be described.

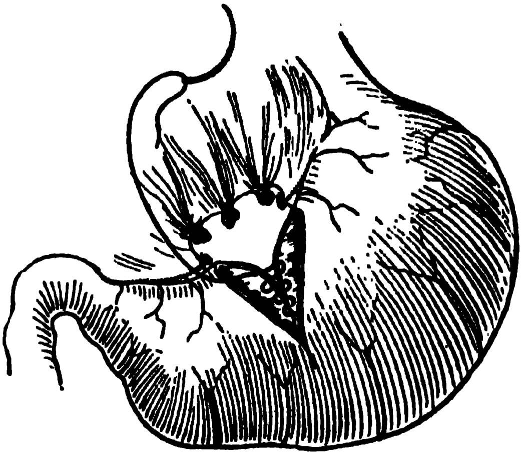


FIG. 15.—EXCISION OF ULCER OF LESSER CURVATURE. Method of suturing after excision.

Excision of Ulcer of the Lesser Curvature.—Make an incision through the right rectus muscle or preferably the median line if the diagnosis has been made and excision determined on. Examine the stomach and determine if it is adherent posteriorly; ligate the coronary artery and vein on the lesser curvature on each side of the ulcer. After ligation, divide the gastrohepatic omentum; free the ulcer posteriorly, pack laparotomy pads into the lesser sac behind the stomach and apply 2 rubber-covered clamps without compression to the stomach on each side of the ulcer, leaving a good free margin of stomach wall on each side of the ulcer for suture. The clamps form a triangle with the tips meeting at the apex of the triangle, the lesser curvature being its base. Excise the ulcer, removing a triangular wedge from both anterior and posterior wall, the common base being the ulcer at the lesser curvature. Make the excised wedge as short as possible so as not to approach the greater curvature any more than necessary and thus cause deformity of the stomach when sutures are inserted. Approximate the clamps. A Connell continuous loop on the mucosa through-and-through suture of 0 chromic catgut is used. Starting at the apex of the posterior triangle, that is, the angle nearest the greater curvature on the posterior stomach wall, the stitch is inserted in the mucosa of one side, passes through all coats, including the serous coat, enters the serosa of the other side through all coats, emerging through the mucosa, reënters the mucosa on same side 1/8 in. (.3 cm.) away, passes through all coats, enters the serosa of the other side, and emerges on the mucosa 1/8 in. (.3 cm.) away from original point of entrance, where it is tied. This continuous stitch which infolds the stomach wall and brings the serous coats in contact, is continued up the V in the posterior stomach wall to the lesser curvature, from which it continues down the anterior wall to the apex of the anterior triangle (Fig. 15).

Remove the clamps, stopping bleeding by extra sutures when necessary; then reinforce the whole suture line with a row of Lembert sutures of Pagenstecher thread, beginning posteriorly and continuing over the anterior stomach wall. Remove the pads, insert a rubber dam drain into the lesser sac, leading it out of the upper angle of the wound, and close the wound.

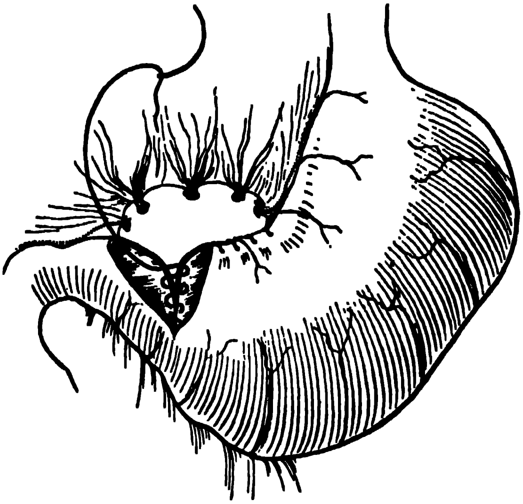


FIG. 16.—EXCISION OF ULCER OF LESSER CURVATURE. Method of suture to avoid approximation of pyloric and cardiac ends of lesser curvature.

It is obvious that the transverse suture of the wound left after the excision of a considerable area of the lesser curvature must necessarily cause shortening of the lesser curvature and, therefore, a great deal of deformity of the stomach, approximating the pylorus to the cardiac orifice. This deformity may be rendered less in some cases by employing the method of suture illustrated in Figure 16.

When the ulcer is small, it may be possible, after freeing the lesser curvature and ligating the coronary, as described above, to grasp the posterior stomach wall about 3/4 in. (2 cm.) below the ulcer with a volsella. Apply a second volsella to the anterior stomach wall ¾ in. (2 cm.) below the ulcer. Pull upon the volsellæ and apply a rubber-covered clamp at right angles to the long axis of the stomach so as to clamp off the fold of the stomach pulled up. Excise the ulcer. Suture vertically with a double row of sutures, as described above, the inner row a chromic catgut Connell suture and the outer a Lembert suture with Pagenstecher thread.

Transgastric Excision of Ulcer of the Posterior Wall.—Ulcers of the posterior stomach wall adherent to the pancreas may in some cases be freed and excised by means of division of the gastrohepatic or gastrocolic omentum and access obtained to them in this manner. In certain cases, however, Wm. J. Mayo (24) has found excision easier by the transgastric method. The operation is performed as follows: After division of the gastrohepatic and gastrocolic omentum, the ulcer is freed as much as possible posteriorly, if possible without opening the stomach. Gauze pads are inserted carefully behind the stomach to stop bleeding and prevent infection. Make a vertical incision in the anterior wall of the stomach, or, if the ulcer is large, and a long incision will probably be needed, make the incision parallel to the long axis of the stomach. If the ulcer can be freed with the left hand through the lesser omentum, the posterior stomach wall bearing the ulcer may be pushed through the incision in the anterior wall and excised. If the ulcer has not been freed, it should be excised by an incision from within the stomach, the incision passing first through the mucous coat of the stomach. To remove the ulcer it may be necessary to shave off a thin layer of pancreas to which it is adherent. The posterior wound is closed by a row of linen serous sutures, then a row of through-and-through catgut sutures. It may be difficult or even impossible to insert properly the row of serous sutures. Mayo closes the posterior wound by a single row of chromic catgut through-and-through sutures, reinforced by a few linen mattress sutures to prevent separation, due to early absorption of the catgut sutures (Fig. 17). The anterior wound should be closed as described, and the lesser sac drained with a folded rubber dam drain through the opening in the gastrohepatic omentum leading out of the abdominal wound.

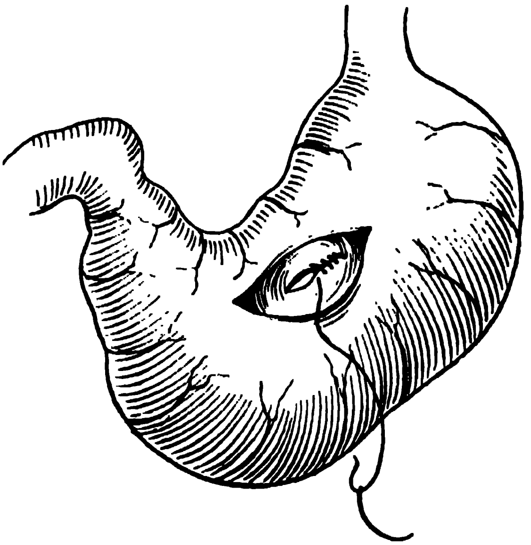


FIG. 17.—TRANSGASTRIC EXCISION OF ULCER OF POSTERIOR WALL OF STOMACH. After method of Mayo

OCCLUSION OF THE PYLORUS

In order to prevent vicious circle, the closure of a non-functionating gastrojejunostomy caused by the gastric contents continuing to leave the stomach through a still patent pylorus, and the passage of the gastric contents over an ulcerated area in the region of the pylorus or in the duodenum, or in order to promote the healing of a duodenal fistula, a number of surgeons practice occlusion of the pylorus in connection with gastrojejunostomy. Paterson (31) considers it an unnecessary complication of gastrojejunostomy. The operation is also advocated by those surgeons who treat cases of gastroptosis by means of gastrojejunostomy.

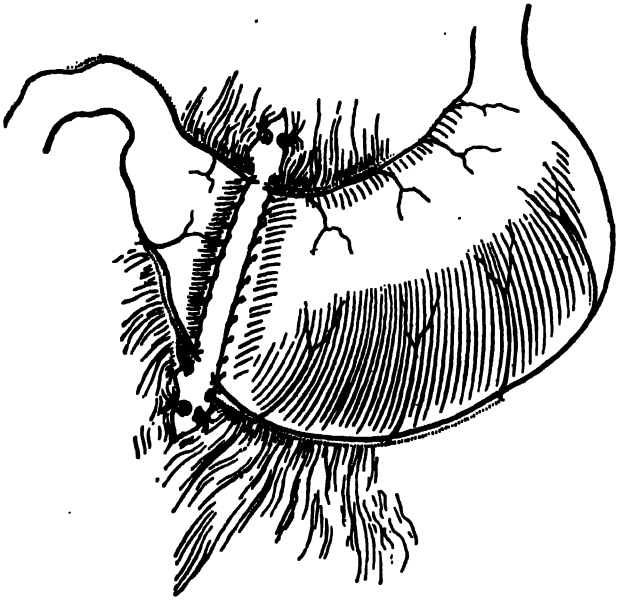


FIG. 18.—OCCLUSION OF THE PYLORUS, VON EISELSBERG'S METHOD.

Indications.—The indications for occlusion of the pylorus are undetermined and the matter is still open to discussion.

Methods.—A large number of methods has been suggested. The most radical is that followed by von Eiselsberg (9), who divides the stomach proximal to the pylorus and inverts the divided ends of the stomach and duodenum, closing each by means of a double row of sutures (Fig. 18). Berg (2) passes a heavy Pagenstecher thread around the pylorus, picking up the subserous coat at a few points to prevent displacement of the occluding thread and tying it just tight enough to occlude the pylorus without cutting into the stomach walls (Fig. 19). This method has been modified by inserting a row of Lembert sutures over the occluding thread, completely burying it (Fig. 20). Others have inserted a double row of occluding sutures, either passing the sutures entirely around the pylorus or pyloric end of the stomach, or, in the event of dense adhesions or induration of the posterior wall, applying the sutures so as to effect an occlusion by the infolding of the anterior wall (Figs. 21, 22). According to the experience of Bier (4), Leriche (20), and others, such occlusion sutures frequently cut through in time and the pylorus again becomes permeable.

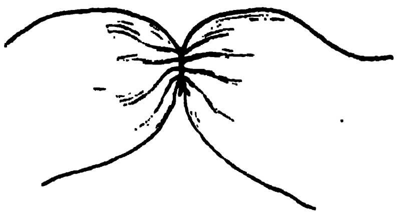


Fig. 19.—Occlusion of the Pylorus by Means of Linen Thread Tied Around Pylorus.

Bogoljuboff (6) and Wilms (44) use fascial strips taken from the posterior rectus sheath, passed around the pylorus and tightened as an occlusion suture and also as a means of suspension of the pylorus. Hoffmann (16) modifies this by division of the serous and muscular coats around the stomach, buries a strip of fascia in the line of incision, and re-unites the divided coats, thus preventing adhesions. Polya (33) uses the ligamentum teres hepatis, which has been removed, as a circumscribing ligature, and Herscher (15), following the idea of Rovsing in cases of hepatosis, divides the end of the round ligament near the umbilicus, passes it around the pylorus, constricting it, and fastens the free end in the upper part of the abdominal incision, thus occluding and suspending the stomach. Girard (11) makes a vertical incision down to but not through the mucous membrane of the pylorus, which he converts by suture into a horizontal suture line, the reverse of what is done in the Heineke-Mikulicz pyloroplasty. Bartlett (1) passes a spatula behind the pyloric portion of the stomach through a slit in the gastrocolic omentum, then thrusts a metal skewer directly through both walls of the stomach into the lesser peritoneal cavity and out again so as to encompass about half the distance between both curvatures. A clamp is placed behind the skewer and several mattress sutures are introduced through the whole thickness of both walls of the stomach, between the skewer

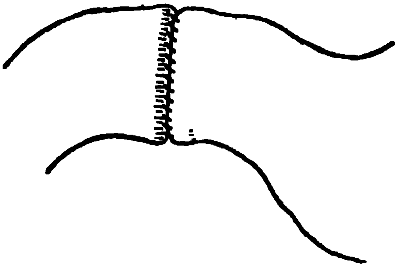


Fig. 20.—Occlusion of the Pylorus. Occluding suture buried by Lembert suture.

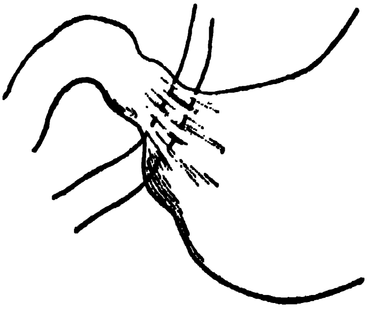


Fig. 21.—Pyloric Occlusion. Method of closure when dense adhesions of posterior wall are present. Sutures inserted in anterior stomach wall proximal to pylorus.

and clamp. With a sharp knife the skewer and stomach wall in front of it is cut out, the mattress suture tied, the clamp then removed. The 4 parallel stomach edges are united with a running suture of Pagenstecher, and the resulting raw edge buried by a continuous Lembert suture.

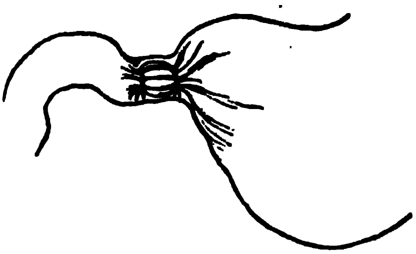


Fig. 22.—Pyloric Occlusion. Sutures shown in Figure 21 tied.

Brewer (7) has made use, in animal experiments, of an aluminum band 1 cm. wide and 5 cm. long folded around the pylorus with sufficient compression to obliterate the lumen.

Which of these many methods will prove most satisfactory only time can tell, as the question of pyloric occlusion is one of the newer developments of gastric surgery.

TREATMENT OF GASTRIC HEMORRHAGE DUE TO ULCER

Indications.—It is generally conceded that profuse hemorrhage from the stomach is best treated by medical means. Mayo quotes Brinton: "Ninety to ninety-six per cent. of gastric and duodenal hemorrhages cease spontaneously. Fatal hemorrhages occur in four to ten per cent., and in fifty-five per cent. of these the splenic vessel is involved." He also quotes Savariand: "Eighteen and one-half per cent. of those dying from hemorrhages die so quickly that an operation could not be performed." The indication for treatment then would be repeated or continued hemorrhage from the stomach which is exsanguinating the patient.

Operative Procedure.—Obviously the ideal method of treatment would be the direct ligation of the bleeding vessel or excision of the bleeding area followed by suture of the stomach wall, but unfortunately in a large percentage of cases the point of hemorrhage cannot be found, as the hemorrhage comes from a small fissure or erosion of the stomach wall, as well as from the edge or eroded base of a callous ulcer, and frequently the condition of the patient renders prolonged search impossible. If the ulcer is found on the anterior wall, excision, if the ulcer is not too large and the patient's condition permits, or inversion should be done. If the anterior wall appears normal, an incision through it may be made for inspection of the posterior wall, as described under transgastric excision of ulcer. This, for the reasons before mentioned, usually proves unsatisfactory. Rovsing (30) in such cases uses a diaphanoscope or a gastroduodenoscope inserted through a small opening and illuminating the stomach, to find the bleeding area. If the ulcer is near either curvature, ligation of the vessels running toward the ulcer may be practiced, as recommended by Witzel.

The indirect method most usually employed is the performance of a posterior gastrojejunostomy, together with infolding of the ulcer whenever possible, a procedure followed by many surgeons. Mayo and others, however, have reported fatal duodenal hemorrhage several days after a posterior gastrojejunostomy. For hemorrhage from pyloric and duodenal ulcers which cannot be excised at the time, if gastrojejunostomy is done, pyloric occlusion should accompany the operation.

The most recent statistics of the results of operation for acute hemorrhage are those of Rodman (35), who reports 10 cases with only 1 death. He collected reports of 33 cases operated on since the reports of Tuffier and of Connell in 1905. There were 8 deaths, a mortality of 24.2 per cent.

TREATMENT OF PERFORATING ULCER OF THE STOMACH OR DUODENUM

The mortality of perforating ulcer of the stomach or duodenum increases with each hour operation is delayed; therefore, rapid diagnosis, as well as rapid operation, is essential to favorable results. The first operation for perforation of an ulcer was performed by v. Mikulicz in 1880.

The incision is made in the epigastric region in the median line or through the right rectus. On opening the peritoneum, gas and fluid escape. The fluid may be thin and cloudy from beginning peritoneal irritation; it may be purulent if the operation has been delayed; or it may contain bile if the ulcer is in the duodenum, or food particles if the opening is large enough, as is not usually the case in the stomach. If the fluid is bile-stained, search the duodenum at once for the ulcer, otherwise examine the stomach. The perforation may be located by the escape of bubbles of gas or by adherent lymph or adhesions. If nothing points to the location, begin the examination in the region of the pylorus and lesser curvature. On locating the ulcer, close it at once if possible with 1 or 2 catgut through-and-through stitches or a purse-string suture. Have the anesthetist pass a stomach tube and empty the stomach. Insert a row of Lembert sutures, inverting the first stitch. In many cases the perforation will be surrounded by an acutely inflamed, indurated area through which the suture immediately cuts. Seidel (38) inserts vertical supporting sutures of heavy silk through all the coats of the stomach on each side of the perforation, tying them loosely, so they will not cut through. Then the closing sutures are inserted horizontally above and below the perforation, the traction being on the supporting sutures. These are covered by a layer of Lembert sutures or by the omentum. When the perforation cannot be closed by suture, which should always be done if possible, it may be closed by omentum sutured into the opening. The gall-bladder has been used for this purpose. If the ulcer is small, excision may be the wisest procedure.

As to the necessity of gastrojejunostomy being performed at the time of closure of the perforation, this should not be done as a routine. If the closure of the perforation of the duodenum or pylorus causes a marked narrowing, it is a necessity. If the closure and subsequent healing of the ulcer are apt to result later in marked narrowing of the pylorus or duodenum, and the operation is performed early, before peritonitis has occurred, and if the patient's condition remains good, gastrojejunostomy may be done at the primary operation; otherwise, it increases the danger to such a degree that it is best postponed to a later time.

After closure of the perforation and the performance of posterior gastrojejunostomy or not, as indicated, the toilet of the peritoneum and the question of drainage will depend on the condition present. With slight soiling of the peritoneum and early operation, gentle sponging in the upper abdomen is all that is necessary, and the wound is closed without drainage. If the operation has been delayed until marked general peritonitis is present, the left hand is passed down under the anterior abdominal wall and a good sized suprapubic stab wound made, through which a large folded rubber dam drain is passed to the bottom of the pelvis. If the closure of the stomach wound is doubtful or there is fear of the stitches cutting, the operative wound should also be drained by a small folded rubber dam drain, otherwise not. The patient is put to bed in the Fowler position and free use is made of rectal enemata of water or the Murphy drip, and of saline by hypodermoclysis.

PLASTIC OPERATIONS ON THE PYLORUS: PYLORODIOSIS, PYLOROPLASTY; GASTRODUODENOSTOMY

Theoretically a plastic operation on the pylorus would appear to be preferable to gastrojejunostomy in the treatment of pyloric stenosis, as the dangers of vicious circle, jejunal ulcer, or intestinal obstruction, which may follow gastrojejunostomy, are removed and the normal physiological process of digestion is less interfered with. However, the simpler methods of pyloroplasty are particularly apt to be followed by a return of the stenosis. In the presence of dense adhesions the Finney method of gastroduodenostomy may be difficult of execution, and in the presence of active ulceration in the pyloric region, gastrojejunostomy, rather than a pyloroplasty or gastroduodenostomy, fulfils the conditions resulting in a cure. However, in cicatricial or spasmodic pyloric stenosis with no tendency to further ulceration about the pylorus or marked hyperacidity, and in congenital hypertrophic stenosis of the pylorus (although in the latter most surgeons perform gastrojejunostomy), the main indications for one of these operations are found.

PYLORODIOSIS

Pylorodiosis or divulsion of the pylorus may be done by *Hahn's method,* which consists in inverting the anterior wall of the stomach with the forefinger, which is pressed through the pyloric ring, thus dilating it to the degree desired. In the *Loretta method,* an incision is made in the anterior stomach wall and the pylorus stretched to the desired degree with the fingers or bougies. The incision in the stomach wall is then closed. As these methods are not without danger and are apt to be followed by a return of the stenosis, other methods are preferable.

PYLOROPLASTY

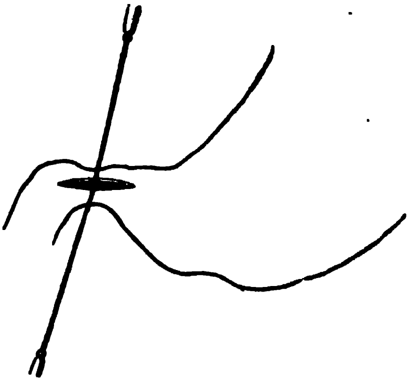


Fig. 23.—Heineke-Mikulicz Pyloroplasty. Horizontal incision made through anterior wall of pylorus. Sharp tenacula inserted to convert horizontal incision into vertical wound before suture.

Heineke-Mikulicz Operation.—While simple of execution, this operation is contra-indicated in the presence of dense adhesions about the pylorus, greatly thickened scar tissue, or an active ulcerative process at the pylorus. The abdomen is opened by a right rectus incision, the whole stomach examined, and the pylorus pulled out of the abdomen if possible and walled off with pads. Rubber-covered clamps are loosely applied on each side of the pylorus on the stomach and duodenum, and a horizontal incision 6 to 7 cm. long is made across (according to the usual description) the anterior wall of the pylorus, completely dividing the structure. If the incision is made shorter, the stenosis is apt to return; if larger, there will probably be too great tension on the sutures. A sharp hook is inserted at the mid point of the upper and lower lip of the incision, and by traction on these hooks the horizontal cut is converted into a vertical one (Fig. 23). The wound is then sutured vertically with a double row of sutures, the inner layers of through-and-through or Connell catgut sutures, the outer layer of Lembert suture of Pagenstecher linen thread (Fig. 24).

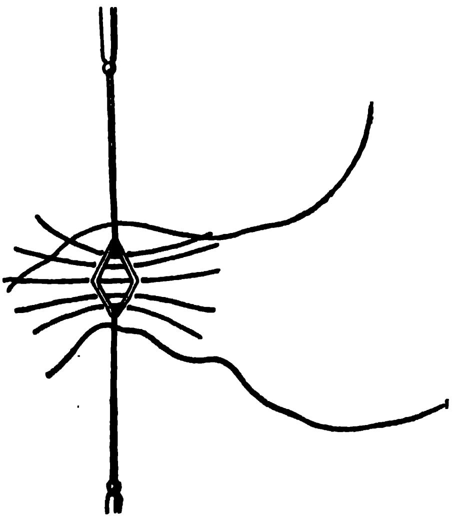


Fig. 24.—Heineke-Mikulicz Pyloroplasty. Sutures inserted converting horizontal into vertical wound.

Mikulicz' Operation.—The above operation is the one usually described. It is apt, however, to be followed by a return of the stenosis. If the incision is made along the lower border of the stenosed pylorus, as described by Mikulicz (Fig. 25), the suture should be made by, first, a posterior continuous Lembert suture uniting the serous coats of the posterior edges of the wound (duodenum to stomach); second, a row of through-and-through sutures through the posterior wall and continued through the anterior wall (Fig. 26); third, a row of Lembert sutures in the anterior wall. This method is an improvement over the one described above, as it enlarges the opening and also brings it to a lower level. It is similar in this respect to Finney's operation.

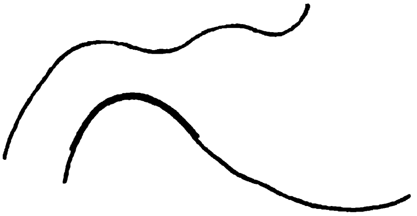


Fig. 25.—Mikulicz Pyloroplasty. Incision along lower border of pylorus extending into duodenum and stomach on each side of pyloric ring.

Nicoll's Pyloroplasty.—Nicoll (28) has reported excellent results in congenital stenosis of the pylorus by means of a plastic operation with divulsion. It may be done with or without division of the mucous membrane.

If the mucous membrane is not to be opened, make an ∧ incision in the pylorus. Make a small incision in the anterior stomach wall near the pylorus, and insert a large clamp through the incision into the stomach and through the pylorus. Open the blades of the clamp as a glove stretcher, and thus divulse the pylorus (Fig. 27). This stretching converts the ∧ into a ⅄ and the wound in the pylorus is so sutured. The wound in the anterior stomach wall is then closed in the usual manner (Fig. 28).

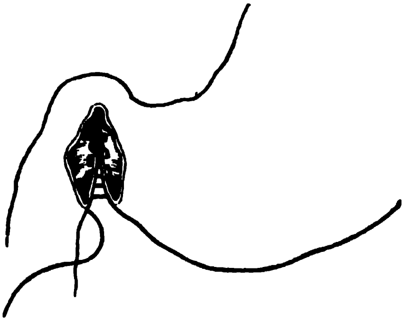


Fig. 26.—Mikulicz Pyloroplasty. Method of inserting second row of sutures, after serous suture not shown in diagram, has been inserted posteriorly.

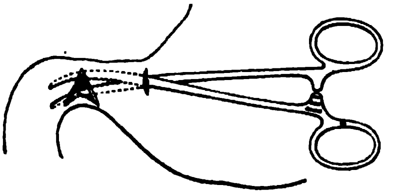


Fig. 27.—Nicoll's Pyloroplasty. Incision through seromuscular coats of pylorus being stretched by clamp inserted through small incision in anterior wall of stomach.

If the mucous membrane is opened in the original ∧ incision, the divulsion is done through the wound, otherwise the operation is the same.

Finney's Operation.—The first gastroduodenostomy was done by Jaboulay in 1894 by means of parallel incisions in the stomach and duodenum united by suture, as in gastrojejunostomy. Kümmell divided the duodenum transversely, closed the proximal end, and implanted the distal end into the anterior stomach wall. These earlier operations have been supplanted by Finney's operation (10).

STEP 1.—Mobilize the pylorus and duodenum. If the duodenum is not movable, it should be pulled to the left and an incision made in the posterior parietal peritoneum between 1 and 2 cm. to the right of and along the descending portion. The fingers, working in behind, free the duodenum from the structures behind it, so that it can be brought into apposition with the pylorus without tension.

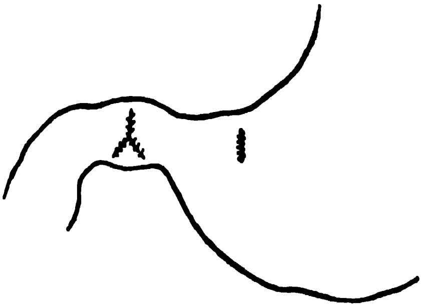


FIG. 28.—NICOLL'S PYLOROPLASTY. Incision converted into Λ and both wounds sutured.

STEP 2.—Insert a linen traction suture in the highest point of the duodenum, a second 10 cm. lower on the anterior wall of the duodenum, and a third opposite the second on the opposite wall of the stomach, so that the two latter points come together to form the lowest point of the anastomosis. Clamps are then applied to the duodenum and stomach in a vertical direction, with the tips of the clamps above grasping those portions of those viscera in which the anastomosis is to be made, but leaving the upper portion of the duodenum, in which the first traction stitch was applied, free. Bring the blades of the clamp together and isolate with gauze abdominal pads. The further technic resembles that described under gastrojejunostomy, except that instead of two parallel incisions, a ∩-shaped incision is made.

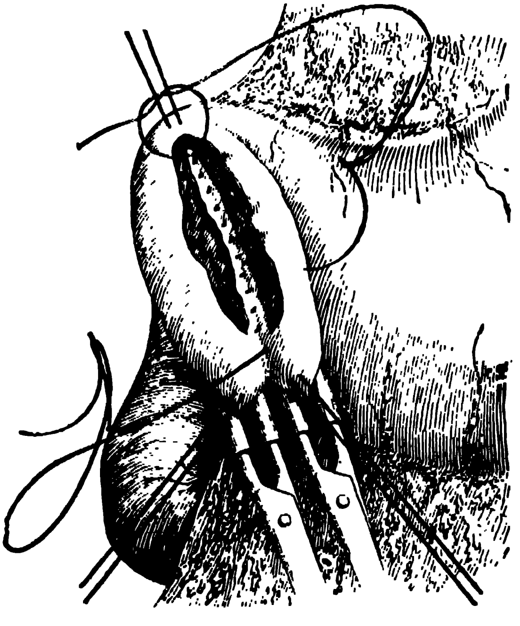


FIG. 29.—FINNEY'S PYLOROPLASTY. Traction sutures inserted. Clamps applied and approximated. Posterior serous suture inserted. Beginning of inner catgut suture.

STEP 3.—Suture the opposing surfaces of the duodenum and stomach with a continuous linen thread suture, making the posterior outer suture layer. Leave the lower end long, with needle attached.

STEP 4.—Make a ∩-shaped incision, the parallel arms shorter than and 1/4 in. (.5 cm.) on each side of the suture line, the horizontal part connecting them, dividing the pyloric constriction (Fig. 29).

STEP 5.—Starting above with a Connell or through-and-through stitch of fine chromic catgut, unite first the posterior edges, then, continuing the suture on reaching the lowest point, the anterior edges of the ∩ incision. Remove the clamps.

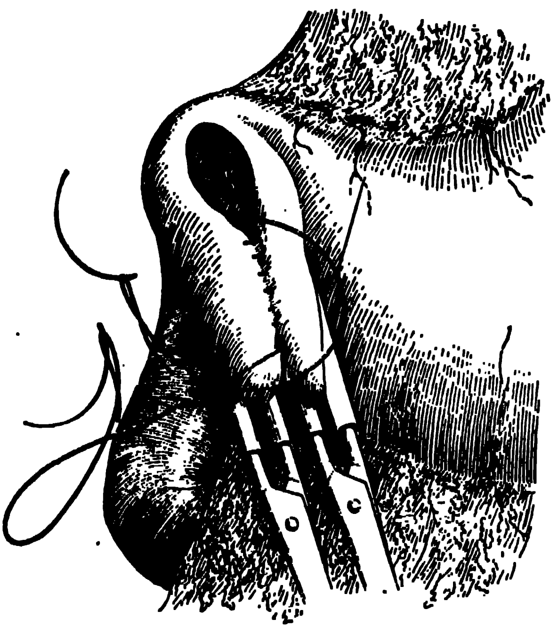


FIG. 30.—FINNEY'S PYLOROPLASTY. Continuation of inner catgut suture on anterior wall.

STEP 6.—Continue the first serous Lembert suture inserted in the posterior wall, inverting the stitch just inserted, through the anterior wall (Fig. 30).

Finney performs the operation by inserting the anterior row of mattress sutures and holding them aside ready to tie before making the incision in the stomach and duodenal walls.

RESULTS.—According to Finney and Friedenwald (11), who report 100 operations performed during the past 13 years, the mortality following the operation was 5 per cent. Satisfactory results were obtained in 88.8 per cent. of the total number from whom reports were obtainable, or 93.6 per cent. of those surviving the operation. Four cases required secondary gastrojejunostomy. Finney and Friedenwald state that "the only contra-indications to the operation are inability to mobilize the duodenum when adhesions are too dense, and thickening and infiltration about the pylorus due to hypertrophic forms of ulceration are present" and "atony or gastroptosis with slight motor insufficiency."

OPERATIONS FOR HOUR-GLASS STOMACH

True hour-glass stomach is a division of the cavity into 2 portions by cicatricial contraction of a chronic ulcer. Usually the ulcer is of the saddle-shaped variety situated on the lesser curvature, the greater curvature being pulled up by the contraction of the anterior and posterior walls in the scar. The ulcer being as a rule nearer the pylorus, the cardiac pouch is usually the larger. Occasionally a chronic ulcer of the posterior stomach wall may cause hour-glass stomach. Again, adhesions due to tuberculous peritonitis or other causes may result in deformity resembling hour-glass stomach in the X-ray picture, and one must guard against the mistake of diagnosing as hour-glass stomach a spasmodic contraction of the stomach wall, a mistake which has been not infrequently made.

The operation performed for the relief of this condition must necessarily depend upon and vary with the condition found. Careful radiographic examination should be made before operation and thorough examination of the whole stomach made before the method of treatment can be determined, as a trifid stomach may exist, or a second constriction at or near the pylorus may be present, while the condition of the ulcer, whether healed or still active, its position in the stomach wall, the density of the scar tissue and the amount of adhesions present, and the size and amount of stasis in one or both pouches all aid in determining which operation can best be performed. The various operations to meet these conditions are as follows:

1. **Posterior Gastrojejunostomy.**—Posterior gastrojejunostomy to the cardiac pouch, either with or without pylorectomy, is applicable in those cases in which the pyloric pouch is small. If the ulcer is healed and there is no obstruction at the pylorus, posterior gastrojejunostomy alone is sufficient. This is usually the operation of choice. Occasionally, due to adhesions posteriorly, an anterior gastrojejunostomy may be necessary. If the ulcer is large and indurated or if there is in addition a pyloric obstruction present, the pyloric pouch should also be excised (Fig. 31).

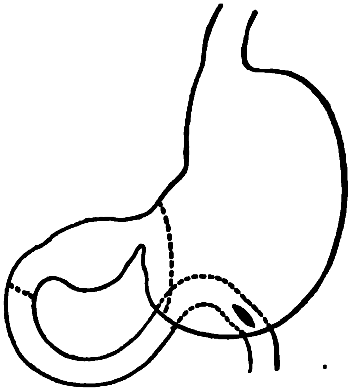


FIG. 31.—HOUR-GLASS STOMACH. Posterior gastrojejunostomy to cardiac pouch. Dotted lines show area excised if pylorectomy is performed.

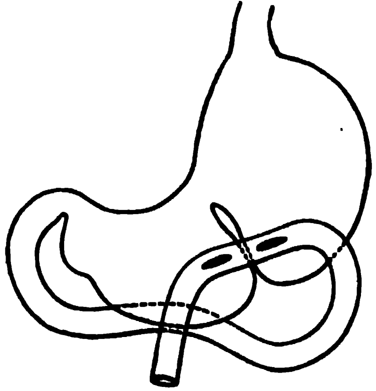


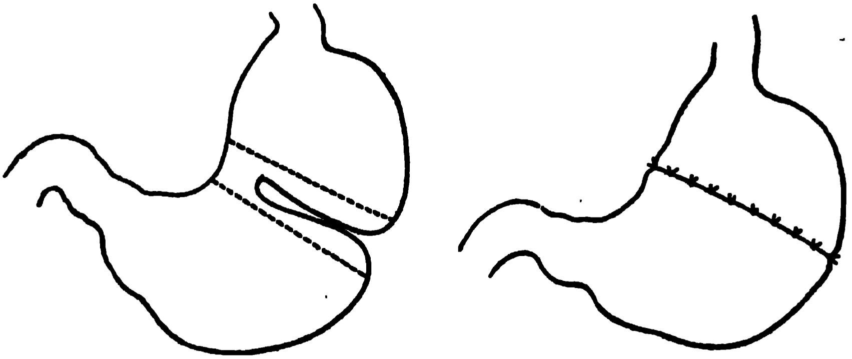
FIG. 32.—HOUR-GLASS STOMACH. Double anterior gastrojejunostomy to empty both pouches.

2. **Double Gastrojejunostomy.**—Double gastrojejunostomy, first performed by Wier and Foote, may be performed in the presence of 2 dilated pouches, each of which fails to empty, the anastomosis of the jejunum being made to each pouch, usually anteriorly. As a rule, other methods are more satisfactory for obvious reasons (Fig. 32).

3. **Resection of the Mid Portion of the Stomach Between Clamps.**—As has been previously stated, chronic ulcers of the lesser curvature do not show the same tendency to heal after gastrojejunostomy as those near the pylorus; therefore, in the presence of hour-glass stomach due to an active ulcer of the lesser curvature or posterior wall, if free mobilization of the stomach is not prevented by adhesions and the affected area is sufficiently accessible to make the opera-

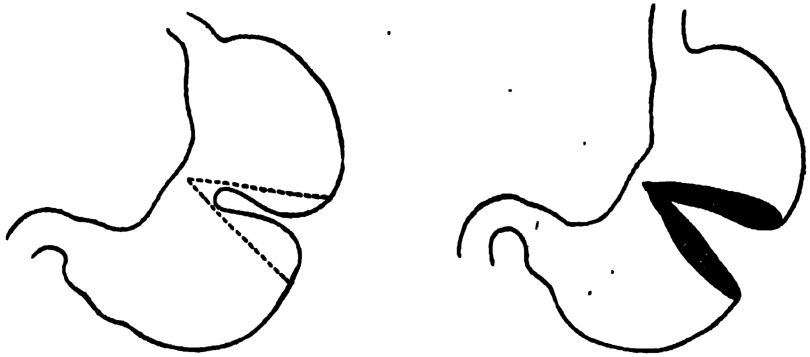
tion not too difficult, or particularly if carcinoma is present or suspected, a resection of the middle portion of the stomach, with a suture to restore its continuity, has been done with most satisfactory results (Figs. 33, 34).

4. **Resection of Wedge-shaped Portion of Stomach.**—Resection of a wedge-shaped portion of the stomach, or anastomosis of the pouches by a method similar to Mikulicz' gastroduodenostomy, may be indicated when the hour-glass condition is due to a healed ulcer of the lesser curvature, and the posterior part of the stomach wall can be freed from or is not bound down by adhesions (Figs. 35, 36).



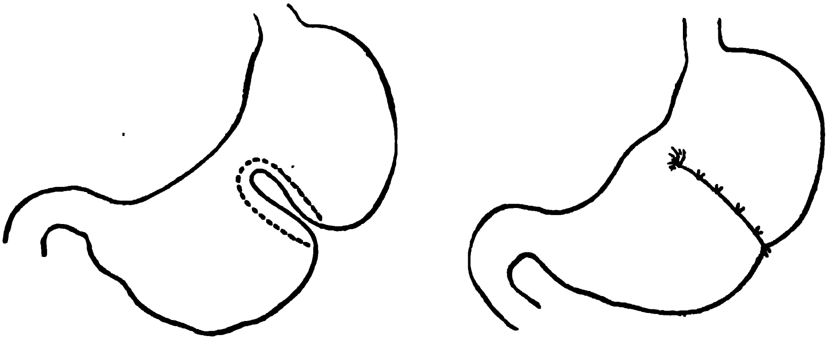
FIGS. 33 AND 34.—HOUR-GLASS STOMACH. Mid-gastric resection.

5. **Kammerer's Method.**—Instead of the above, particularly in those cases in which difficulty in freeing the posterior wall is present, the anastomosis between the 2 pouches may be made by the application to the stomach of Finney's method of pyloroplasty. Clamps are applied to each pouch, almost meeting above, the first layer of serous sutures unites the 2 pouches, the ∩ incision is made with the vertical arms in the anterior wall of each pouch united above with the horizontal division of the isthmus (see Figs. 37, 38, and Finney's gastroduodenostomy).



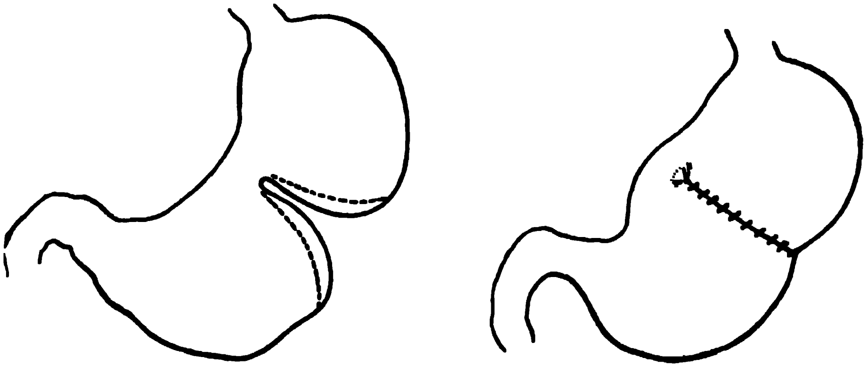
FIGS. 35 AND 36.—HOUR-GLASS STOMACH. Resection of wedge-shaped portion of stomach wall.

6. **Gastrogastrostomy of Lower Border of Pouches.**—Instead of performing the anastomosis between the lower edge of the pouches by Kammerer's method, the anastomosis may be made by means of an incision in each pouch parallel with the drawn-up edges of the greater curvature, these edges having been previously sutured together with a seromuscular suture. The latter corresponds to the first layer of suture applied in performing gastrojejunostomy, and the gastrogastrostomy sutures are applied as in the latter operation (Figs. 39, 40).



FIGS. 37 AND 38.—HOUR-GLASS STOMACH. Kammerer's method of gastrogastrostomy.

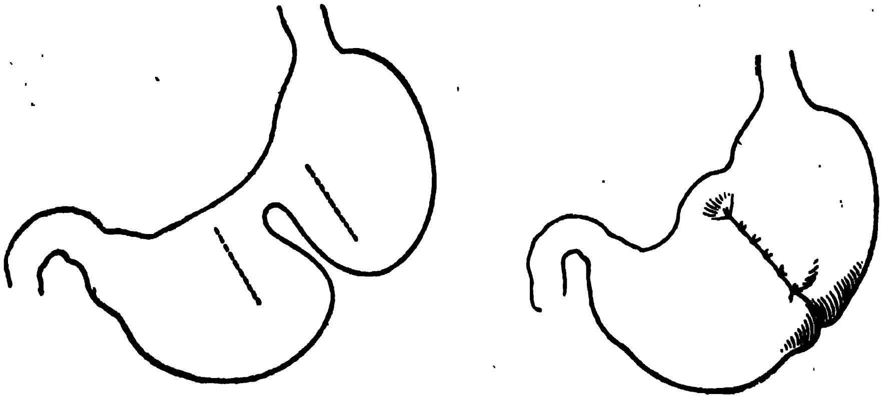
7. **Anterior Gastrogastrostomy.**—Anterior gastrogastrostomy is only indicated for stenosis at the center of the anterior wall of the stomach, and makes use of the healthy tissue on each side of the contracted area. These healthy portions are picked up in a clamp, laid side by side, and a gastrogastrostomy is performed exactly as described under Gastrojejunostomy (Figs. 41, 42). The objection to this operation is the further deformity of the stomach which it causes, and it is not recommended when other methods can be employed.



FIGS. 39 AND 40.—HOUR-GLASS STOMACH. Gastrogastrostomy between lower borders of two pouches.

These last methods of plastic operation on the stomach cannot be employed in the presence of pyloric obstruction and consequent failure of emptying of the pyloric pouch, unless a pyloroplasty or gastrojejunostomy is also performed.

Other Methods.—Digital divulsion and gastroplasty similar to that described under pyloroplasty, by the conversion of a horizontal into a vertical incision, have also been employed, but usually, although not always, with recurrence of the symptoms, and the previously described methods are better adapted to obtain satisfactory results. As previously stated, the variations in the conditions met with must modify the operative procedure. In all operations tension on the suture line must be avoided as in all plastic operations, and the suturing done in healthy tissue where possible.



FIGS. 41 AND 42.—HOUR-GLASS STOMACH. Anterior gastrogastrostomy.

When the constriction is due to carcinoma, excision should be done if possible. If this is impracticable, gastrojejunostomy to the cardiac pouch should be performed as a palliative measure when obstruction is present.

OPERATIONS FOR CARCINOMA OF THE STOMACH: PYLORECTOMY; PARTIAL GASTRECTOMY

Carcinoma of the stomach begins in a large per cent. of the cases in the pyloric region, usually on the lesser curvature; therefore, the operation for its removal usually consists in a pylorectomy with the removal of that portion of the stomach and lymphatic glands along which the growth extends. Microscopical examination has demonstrated that the infiltration extends in the submucosa a considerable distance beyond where it is either visible or palpable, and that this extension proceeds most rapidly along the lesser curvature. Also, while carcinoma of the pylorus does not, as a rule, extend into the duodenum, as the connective tissue of the pylorus becomes dense and poor in lymphatics, the work of Cuneo and of Borrmann has shown that this extension may occur. Removal of the growth in the stomach without the removal of all of the involved lymphatic glands is futile, and as these glands are involved at an early stage of the disease, a knowledge of the direction of the lymphatic drainage and the location of the various groups of lymph nodes into which the lymphatics drain is necessary (see Surgical Anatomy).

The rapid spread along the coronary group on the lesser curvature almost to the esophagus and then along the course of the coronary artery in the falx to the glands in front of the celiac axis, and the direct involvement of the suprapyloric and subpyloric group and the chain along the gastro-epiploica dextra near the pyloris, with secondary drainage into the suprapancreatic and superior mesenteric and biliary chain of glands must be remembered, and if a radical operation is contemplated these lymph nodes must be examined. Because of the reasons given, the resected area should include, on the cardiac side 1½ to 2 in. (3.5 to 5 cm.) beyond the margin of the growth, 1 in. (2.5 cm.) of the duodenum, the whole of the lesser curvature, and half of the greater curvature.

Indications and Contra-indications for Operation.—Carcinoma of the stomach can only be cured by complete removal of all the diseased area and the involved lymphatic glands. A thorough study of the radiogram will often indicate the hopelessness of operative procedure. The presence of marked cachexia, palpable lymphatic glands, and evidence of metastasis in the liver or on the peritoneum, as shown in the latter case by ascites, contra-indicate a radical operation. The size of the tumor, however, is not always a contra-indication to operation, as a large, slowly growing carcinoma may not become as adherent to neighboring viscera or cause as early glandular involvement as a smaller, more malignant growth.

If, in the absence of these contra-indications, an exploratory incision is made, the possibility of freeing the carcinomatous area must be determined. Although the tumor may be adherent to the pancreas, this is no contra-indication unless the adhesions are so dense that it would be necessary to remove more than a superficial slice from the surface of the pancreas to free the growth. So, also, involvement of the mesocolon or colon is not an absolute contra-indication, as successful partial gastrectomy with removal of part of the transverse colon, although a difficult operation, has been reported a number of times.

If, after opening the peritoneum, metastases in the liver, peritoneum, or the deep glands about the celiac axis, or beyond the area possible of removal, are found, or if the mesentery of the small intestine is involved in the growth, radical cure is impossible. In the presence of irremovable cancer, if the growth involves the pylorus, causing stenosis and resulting gastric stasis, a gastrojejunostomy should be performed. In the absence of pyloric stenosis, a gastrojejunostomy is more apt to do harm. In the presence of a large carcinomatous ulcer of the pylorus with a foul, discharging base in the stomach, even if small metastases are present in the liver or all the glands cannot be removed, if the primary tumor can be freed without great difficulty and removed without endangering the life of the patient, partial gastrectomy has been advocated. This would seem good practice, as even if there is an extension of the growth or of the metastases, the life of the patient is frequently prolonged for a year or more, pain is relieved, the ulcerating area is removed from the stomach, and afterward there is frequently an increase of 20 or 30 pounds in weight. Furthermore, the mortality in such cases is little greater than if a gastrojejunostomy alone is performed.

PARTIAL GASTRECTOMY

Technic of Operation.—STEP 1.—Make a median incision in the epigastric region from the tip of the ensiform to just above the umbilicus (add a transverse incision if necessary). Examine and palpate the liver and gall-bladder region and the lymphatic glands of the various regions indicated under Surgical Anatomy. Determine the mobility of growth and whether it can be freed from adhesions. Insert a double layer of laparotomy pads to wall off the peritoneal contents below. Tear a small hole in the gastrohepatic omentum, insert 2 fingers of the left hand and palpate the posterior wall of the pyloric portion of the stomach to determine if it can be freed posteriorly. Pull down the stomach to make the gastrohepatic omentum tense. Tie off the gastrohepatic omentum with catgut ligatures threaded 2 at once on an aneurysm needle. The

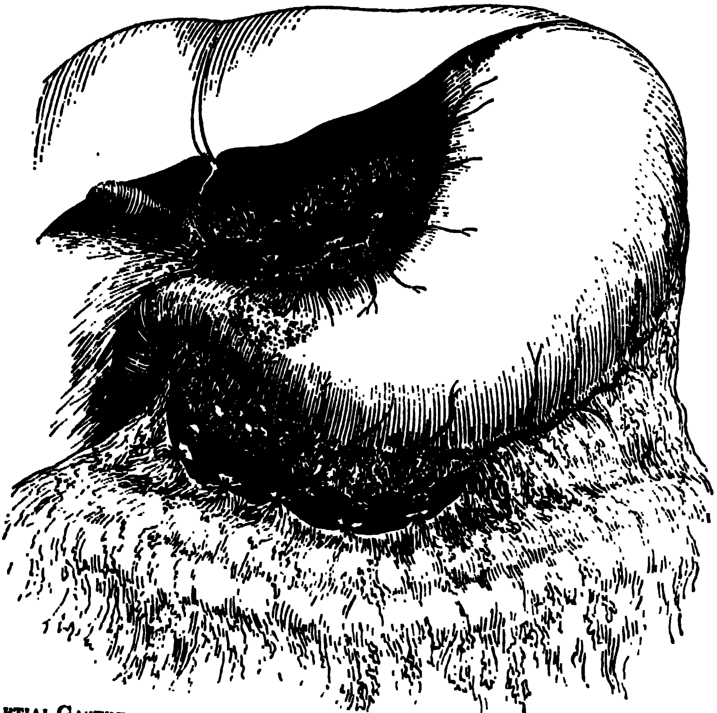


FIG. 43.—PARTIAL GASTRECTOMY. Gastrohepatic and gastrocolic omentum ligated and divided. Ligatures on coronary, pyloric, gastroduodenalis and gastro-epiploica sinistra vessels.

ligature nearest the stomach should be at a sufficient distance from the lesser curvature to leave attached to the latter any glands which may be present. Four ligatures are usually sufficient for this purpose. Through the opening made, feel to the left in the falx coronaria and locate the coronary vessels as they run in the falx to the beginning of the lesser curvature. Ligate the coronary vessels with catgut on an aneurysm needle. Separate the peritoneal attachments of the duodenum above and ligate the pyloric and gastroduodenal arteries and divide them between the ligatures. Pass the left hand behind the first portion of the duodenum and pylorus, lifting them forward and freeing them posteriorly. The part to be resected has now been freed from its attachments above and its blood supply has been ligated and divided.

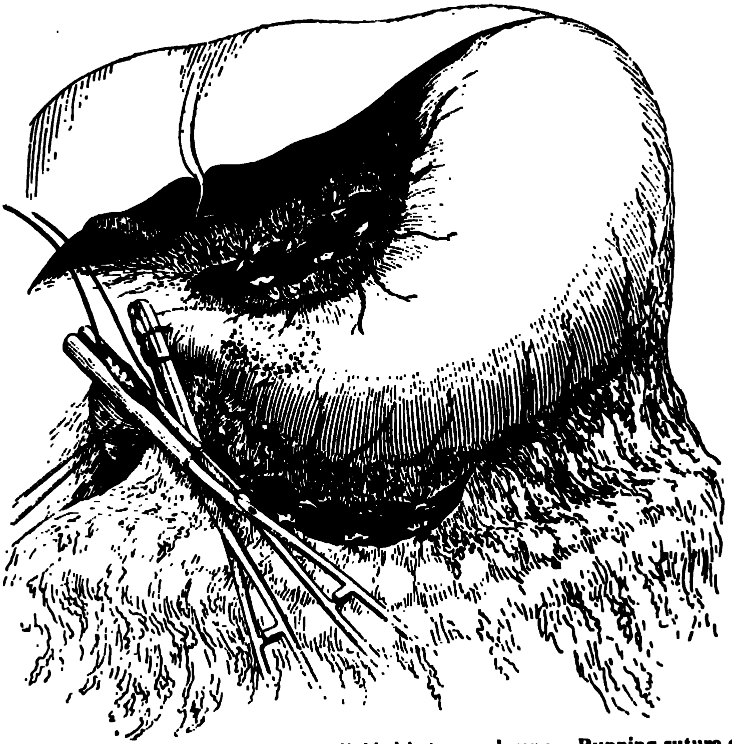


FIG. 44.—PARTIAL GASTRECTOMY. Duodenum divided between clamps. Running suture over end of duodenal stump, and purse string for inversion of stump ready to tie.

STEP 2.—Pass the left hand behind the stomach, separating attachments to the pancreas if present; lifting up the gastrocolic omentum, tie off the anterior layers of the gastrocolic omentum in segments, carefully avoiding the colica media artery and its branches, injury to which would cause gangrene of that part of the colon supplied by it. The ligation of the gastrocolic omentum extends to the left, well beyond any involved area or glands, usually to the middle of the greater curvature. At this point the gastro-epiploica sinistra is tied. Ligature of the omentum must be at a sufficient distance from the greater curvature to leave all involved glands attached to the stomach. If the gastroduodenalis has not been ligated, its branch, the gastro-epiploica dextra, must now be ligated. Lift up the separated pylorus and attached omentum and glands, and, working to the right, remove all fat and glands above the head of the pancreas, ligating the anastomosing branches of the gastroduodenalis and the superior pancreaticoduodenal arteries, thus freeing the duodenum below and to the left and removing all glands. The portion of the stomach to be resected and the duodenum are now free from attachments below, the blood supply has been cut off, and the actual resection may be proceeded with (Fig. 43).

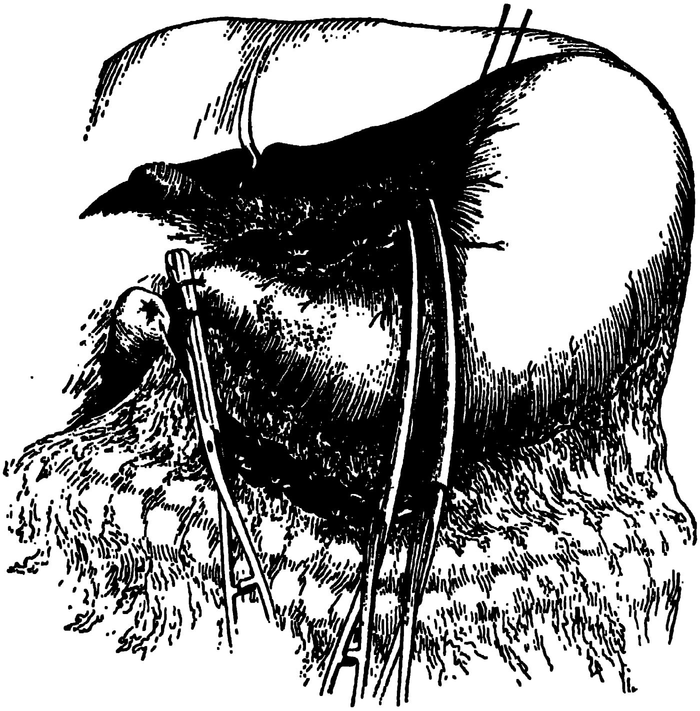


FIG. 45.—PARTIAL GASTRECTOMY. Purse string on duodenal stump tied. Clamps applied to stomach and division of stomach begun. Guy suture applied to lesser curvature in case of stomach slipping through clamp.

STEP 3.—Apply 2 clamps to the duodenum, the distal one, with blades covered with rubber tubing, 1¼ in. (3 cm.) from the pyloric ring, the proximal one, with bare blades, clamped as tight as possible ¾ in. (1.5 cm.) nearer the pylorus. Insert a purse-string suture of linen thread about the duodenum ⅜ in. (1 cm.) distal to the clamp first applied but do not tie. Divide the duodenum with cautery or knife between the 2 clamps. Pass a couple of sutures through the proximal duodenal stump and tie them over the clamp to prevent slipping of the stump through the grasp of the clamp. (Discard the needle.) Insert a running over-and-over catgut stitch through the projecting end of the distal stump and remove the clamp as the first knot is tied (Fig. 44). This puckers up the end of the stump. Invert the stump, tying the purse-string suture previously inserted. Moynihan recommends the insertion of a third row of sutures, as it is from the duodenal stump that leakage is most apt to occur. If the duodenum is sufficiently mobilized, the stump may be attached to the anterior surface of the head of the pancreas, this procedure being especially desirable, as recommended by Mayo, in those cases in which the pancreas has been injured, due to attachment of the growth.

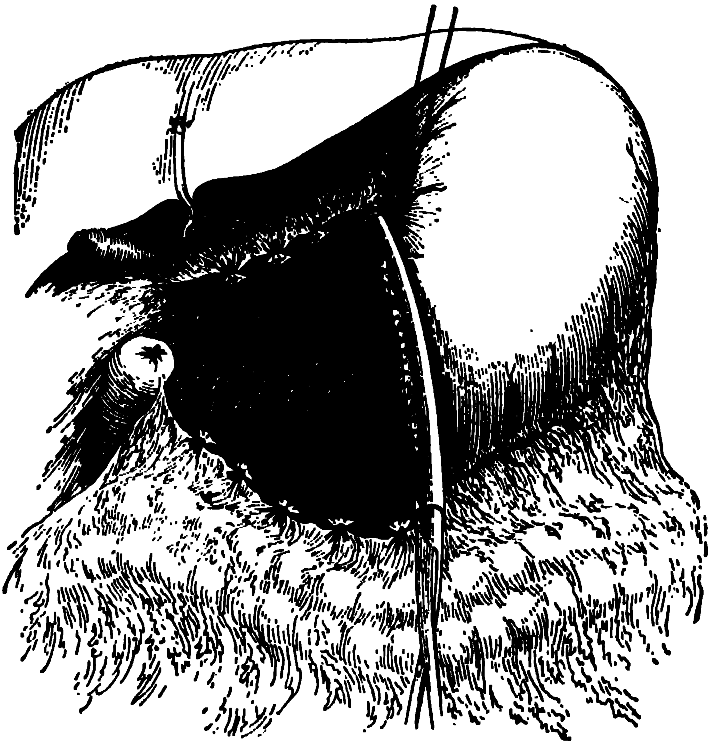


Fig. 46.—Partial Gastrectomy. Resected area removed. Suture of stomach with over-and-over chromic catgut stitch.

STEP 4.—Determine the line of resection of the stomach and apply a Kocher or Moynihan clamp, with the blades protected with rubber tubing, ½ in. (1.25 cm.) proximal to this line. Insert a stay suture of linen in the lesser curvature proximal to the clamp, in case of slipping of the clamp. Apply a second clamp, with bare blades, tightly to the stomach ½ in. (1.25 cm.) distal to the first clamp. Divide the stomach between the clamps with cautery or knife, leaving ¼ in. (.5 cm.) of stomach wall projecting from the grasp of the proximal clamp (Fig. 45). As the division is made, grasp the projecting edges with Allis clamps or volsellæ to prevent the stomach slipping from the grasp of the clamp. Suture the divided stomach with through-and-through or interlocking stitches of chromic catgut through all layers of the stomach outside of the grasp of the clamp, pulling each stitch tight to secure hemostasis (Fig. 46). Remove the clamp. Insert a continuous Lembert stitch of linen thread, inverting the first layer and insuring broad apposition of the serous coats, reinforcing the stitch at any necessary point. Particular care must be exercised in applying the sutures at the greater and lesser curvatures.

STEP 5.—Perform gastrojejunostomy, using the posterior no-loop method where possible, by suture method or Murphy button (Fig. 47).

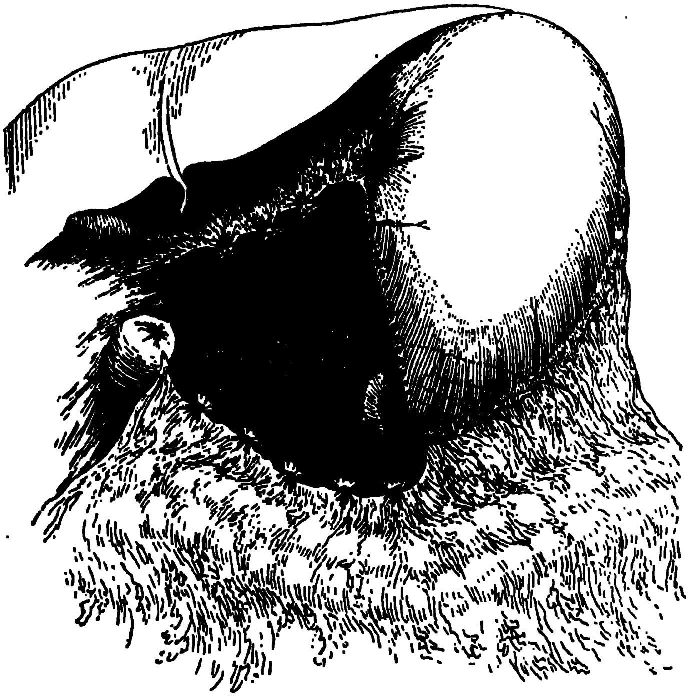


FIG. 47.—PARTIAL GASTRECTOMY. Second row of sutures inserted in stomach. Posterior gastrojejunostomy performed at lower angle of remaining portion of stomach.

STEP 6.—Remove pads and close the abdominal wound. Occasionally drainage need not be employed. If, however, the clamps have slipped and there has been soiling of the peritoneum, or there have been many adhesions, particularly if the pancreas has been damaged, or absolute surety of the duodenal stump is absent, it is wiser to insert a rubber dam drain.

Modifications and Other Methods of Partial Gastrectomy.—The above technic closely follows that employed by the majority of American surgeons and is an elaboration of the Billroth No. 2 method, Billroth having been the first surgeon to perform pylorectomy. The main variations from the above method consist in the order of the different procedures, and in the manner of anastomosing the intestine to the portion of stomach remaining.

Moynihan, after dividing the pylorus, performs a posterior gastrojejunostomy before dividing the stomach. Kocher makes the section through the stomach first and then anastomoses the end of the duodenum to the posterior wall of the remaining portion of the stomach. While this may be done after pylorectomy for ulcer, it is difficult to see how sufficient mobilization can be obtained to effect this anastomosis after such a resection as experience has proved necessary to effect the cure of carcinoma of the pyloric portion of the stomach. Kocher, however, maintains that no more of the duodenum is necessary to perform his anastomosis than is required for a proper occlusion of the duodenal stump. The Billroth No. 1 method of suturing the duodenum to the lower end of the line of suture of the stomach has been generally discarded, and the method of anastomosis by suturing an opening in a loop of jejunum to the lower part of the suture line of the stomach, as in a lateral anastomosis, has little to recommend it. Operation in 2 stages, gastrojejunostomy being done as a preliminary 10 days or more before resection, has been advocated by a number of surgeons in certain cases.

Pylorectomy for Ulcer: Rodman's Operation.—Rodman's operation is performed by the above method, only differing in the more limited extent of the resection and the absence of the necessity of removal of the lymphatic glands.

After-treatment.—Place the patient in Fowler's position or propped up in bed. Give by rectum 10 oz. of water or coffee at the end of the operation, then 6 oz. of water every 4 hours. Hypodermoclysis and morphin may be given if necessary. Administer water by mouth in small quantities at the end of 24 hours, increasing the amount at the end of 36 hours; predigested liquid food oz. ss. on cracked ice q. 2 hrs. at the end of 48 hours; broth in small quantities at the end of 72 hours, gradually increasing the amount and variety of fluids and adding junket, custard, milk toast, etc., at the end of 5 days if the stomach tolerates fluids well. If the patient is very weak, rectal feeding during the first 3 days may be necessary.

Results.—With earlier diagnosis and improved technic, the immediate mortality of partial gastrectomy has been reduced from 64 per cent. in Billroth's original series of cases to 4 per cent. in the last 50 cases reported from the Mayo Clinic at Rochester (26). The same author reports 36 per cent. alive after 3 years and 22 per cent. after 5 years. Weil (42), in 1913, reporting on 104 cases who survived the operation of resection for carcinoma of the stomach in Küttner's Clinic during the previous 5½ years, stated that 40 patients were still alive, and 8 for more than 3 years.

Obviously, favorable statistics for the ultimate cure of cancer of the stomach can only be obtained by early operation before glandular involvement and metastases occur. However, the fact that recurrences do occur so frequently should not prevent resection in cases of pyloric carcinoma, even where recurrence seems probable, as life is prolonged, pain and vomiting are relieved, the patient's condition is greatly improved, frequently for over 2 or more years, and the mortality is not sufficiently great to contra-indicate the operation as a palliative measure in certain advanced cases, with the fair prospect of ultimate cure in those less advanced.

TOTAL AND SUBTOTAL GASTRECTOMY

Total gastrectomy is seldom performed with a prospect of ultimate cure of the patient. However, the whole stomach has been successfully removed a number of times (first by Schlatter in 1897), and there are certain cases of schirrous carcinoma (Schrumpfmagen) of the stomach involving the whole stomach or the cardiac end in which adhesions and glandular involvement are slow in developing, in which total or subtotal gastrectomy or resection of the cardia can be successfully performed.

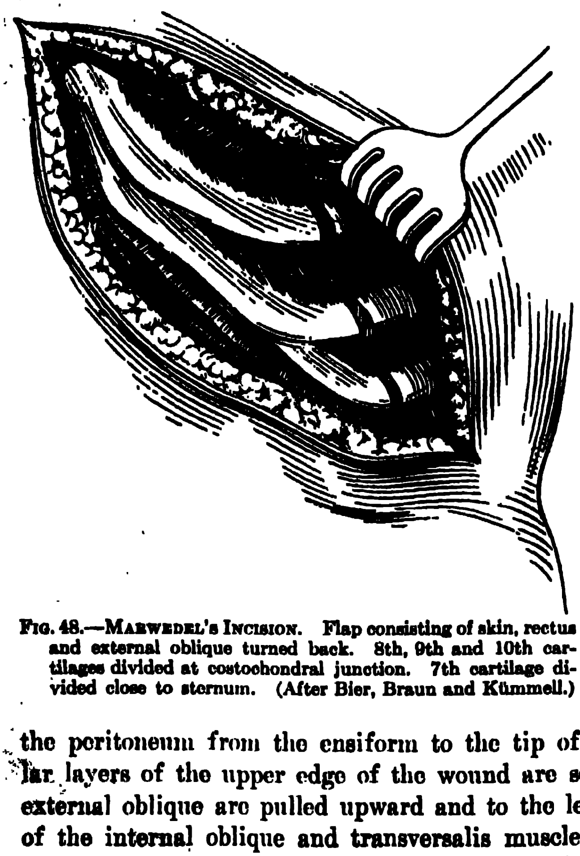


FIG. 48.—MARWEDEL'S INCISION. Flap consisting of skin, rectus and external oblique turned back. 8th, 9th and 10th cartilages divided at costochondral junction. 7th cartilage divided close to sternum. (After Bier, Braun and Kümmell.)

The cardia and esophageal end of the stomach are difficult of access and, therefore, a long incision from the ensiform to the umbilicus is made. In addition, division of the ensiform and left costal margin may be necessary. For operations on the cardia, Marwedel's (21) incision gives an excellent exposure (Fig. 48). This consists in an incision 1 in. (2.5 cm.) below the left costal margin through the peritoneum from the ensiform to the tip of the tenth rib. The muscular layers of the upper edge of the wound are separated, and the rectus and external oblique are pulled upward and to the left, leaving the divided edges of the internal oblique and transversalis muscles attached to the inner edge of the costal arch. The seventh costal cartilage is divided close to the sternum, and the eighth, ninth and tenth cartilages at the costochondral junction. This allows the turning of a large flap upward and to the left, giving access to the cardia and esophageal opening. Care must be taken to avoid injury of the pleura. This incision is the one employed by many European surgeons. Its disadvantage, however, is that it results in the division of the seventh, eighth and ninth intercostal nerves supplying the upper abdominal muscles of the corresponding side. For this reason the Mikulicz incision is probably a better one. This begins at the ensiform and extends to just above the umbilicus, where it turns to the left to the tip of the tenth rib and divides the left rectus muscle. It is supplemented by a second incision below the left breast over the eighth rib, through which the seventh, eighth and ninth ribs are divided without injury to the pleura.

The total resection is performed as in partial resection, by ligature of the gastrohepatic and gastrocolic omenta and division of the duodenum. The gastrosplenic and gastrophrenic ligaments are ligated and the whole stomach freed. The lower 2 or 3 cm. of the esophagus (*pars intra-abdominalis*) is covered with peritoneum, and if this can be used for anastomosis, the prospect of good union is far better than if the carcinoma involves the entrance of the esophagus and this has to be removed and the esophagus pulled down, which can be done for a short distance only. A clamp is applied loosely to the end of the esophagus and the stomach removed. In cases of contracted stomach, the pyloric and esophageal openings have been drawn somewhat together, and Kocher recommends the end-to-end anastomosis of the duodenal stump to the esophagus by a double row of silk sutures. Where the duodenal stump cannot be brought up, it is closed as in partial gastrectomy, and the anastomosis made by implanting the esophagus into a loop of jejunum. Any tension on the anastomosis is bound to be fatal to a favorable result. The Murphy button has been employed in making the anastomosis, but should never be used if the esophageal stump is not entirely covered with peritoneum.

A considerable number of cases reported as total gastrectomies were probably subtotal, as even a small portion of the cardia remaining makes the anastomosis easier. The right vagus nerve lies behind, the left vagus in front of the lower part of the esophagus. These should be avoided if possible, but they have been divided in the course of resection, as reported by Volker (41), without evil result.

GASTROSTOMY

Indications.—Stenosis of the esophagus, whether due to impermeable stricture following ulceration or carcinoma or to carcinoma of the cardiac end of the stomach, preventing the passage of fluids and nourishment to the stomach, indicates the performance of gastrostomy. Gastrostomy is also done as an essential part of Abbe's string method of dilatation of esophageal strictures, due to ulceration caused by the swallowing of corrosive liquids, and has recently been advocated as a preliminary operation to laryngectomy.

The result aimed at is the establishment of a fistula leading into the stomach, through which a tube can be passed and food introduced into the stomach. Attempts to avoid leakage of the fistula, with consequent irritation of the skin of the abdominal wall by the gastric juice, have prompted the development of many different methods of gastrostomy with this object in view. In general, 2 methods of attaining this result have been attempted: 1. The formation of a valve from the stomach wall, as in the Stamm, Kader and Witzel methods; 2. The use of a portion of the stomach wall pulled out of the abdominal cavity between the muscular layers of the abdominal wall, in an attempt to obtain a sphincteric action of the muscle, as in the methods of Terrier, Jaboulay and Hartmann, or the Frank, Ssabanejew-Albert methods.

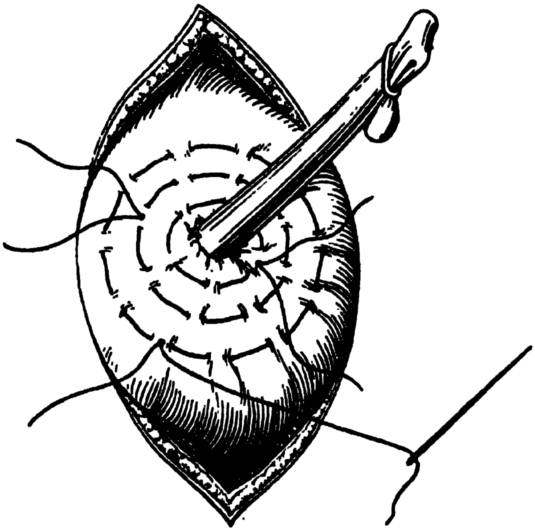


FIG. 49. — GASTROSTOMY: STAMM'S METHOD. Three purse-string sutures of linen thread inserted for inversion to form valve of stomach wall.

The patients on whom this operation is performed are usually weak and emaciated from starvation, and frequently the operation is best done with local anesthesia. For the same reason an operation which can be rapidly and easily done is the operation of choice, and as it is simple, easily performed, as effective as any in the prevention of leakage, and does not require much of the stomach wall, which is frequently contracted, the Stamm method, or, as it is frequently called, the Senn method, is the form of gastrostomy usually chosen.

Stamm Method (Figs. 49, 50).—Make a vertical incision 2 to 3 in. (5 to 7.5 cm.) long through the left rectus muscle just below the costal margin. Open the peritoneum and locate the stomach, being sure not to mistake the transverse colon for the stomach. Pull out of the wound the portion of the stomach near the greater curvature and cardiac end. If the opening is made too near the lesser curvature, there will be tension, and if too near the pylorus, the deformity will prevent emptying of the stomach. Make a small opening only sufficiently large to introduce a 25 F. catheter in the wall of stomach. Introduce the catheter about 2 in. (5 cm.) into the stomach and fix

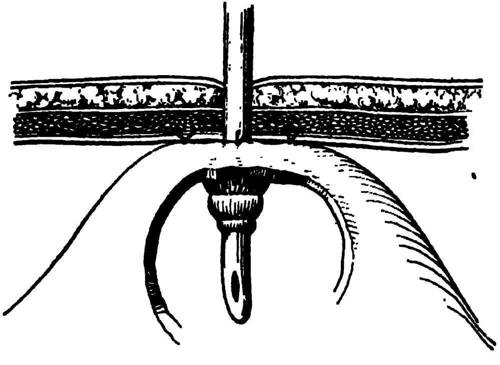


FIG. 50. — GASTROSTOMY: STAMM'S METHOD. Seen from within stomach.

with a couple of fine catgut sutures to the edge of the small opening in the stomach. Introduce a linen Lembert purse-string suture around the edges of the opening where the catheter enters the stomach and tie tightly. Introduce a second purse-string suture ½ in. (1.25 cm.) distant from the first and tie as the stomach wall is inverted by pushing the catheter inward. If there is sufficient loose stomach wall, a third purse-string suture is inserted just as the second was. The ends of the last purse-string are left long and used to attach the stomach wall to the parietal peritoneum. Two or 3 other sutures are also employed to attach the stomach wall to the parietal peritoneum to prevent peritoneal infection in the event of leakage. Close the wound, leaving a small rubber dam drain wrapped around the tube as it passes through the abdominal wall, to prevent the formation of a subcutaneous abscess. The resistance of these patients is low and infection easily occurs. The tube should be additionally fixed to prevent it pulling out or being pushed too far into the stomach. This is best done by means of a safety pin, which is passed through a narrow strip of sterile adhesive plaster wrapped 2 or 3 times around the tube at the level where it emerges from the wound. If the pin is passed through the tube itself, it causes leakage. At the conclusion of the operation, test the permeability of the tube with water poured in through a funnel.

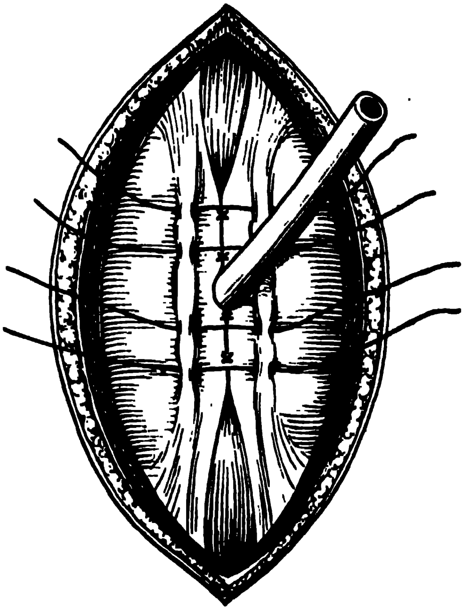


FIG. 51.—GASTROSTOMY: KADER'S METHOD. Two sutures above and two below point of entrance of catheter, forming vertical fold, tied; second row inserted ready to tie.

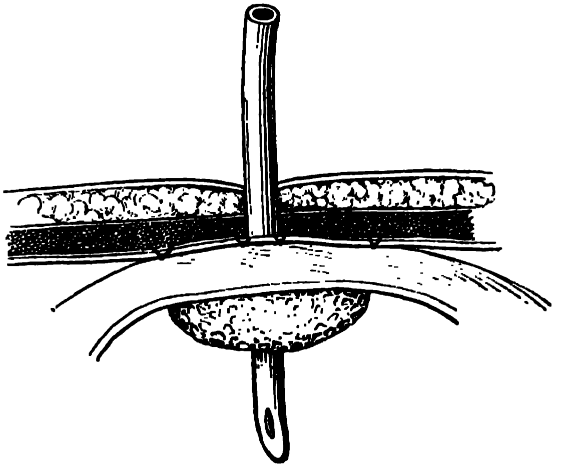


FIG. 52.—GASTROSTOMY: KADER'S METHOD. Seen from within stomach.

AFTER-TREATMENT.—For the first 72 hours after operation, it is safer not to introduce nourishment through the tube, but to depend upon rectal feeding for that time. If, however, rectal alimentation cannot be carried out, predigested liquid foods, or even milk or broth, may be administered. If, at the time of operation, the necessity of early administration of nourishment through the gastrostomy opening is foreseen, the tube may be passed through the stomach into the duodenum at the time of the operation and so fixed, in which case the administration of nourishment may be begun at once.

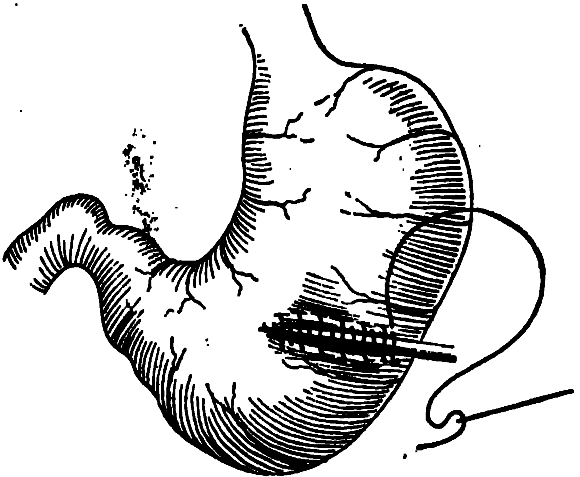


FIG. 53.—GASTROSTOMY: WITZEL'S METHOD. Catheter introduced into stomach through opening in anterior wall. Suture inserted pulling up ridge of stomach wall on each side of catheter to form canal of stomach wall through which catheter runs.

Kader Method.—The Kader method (Figs. 51, 52) differs from the Stamm method only in the manner of inserting the suture to infold the stomach wall. It makes use of 2 straight rows of interrupted Lembert sutures instead of the purse-string sutures of the Stamm method.

After making the abdominal incision, locating and pulling out a small portion of the stomach, introducing the catheter and fixing it with 1 or 2 catgut sutures in a small opening in the stomach wall, as described in Stamm's method, insert in the stomach wall 2 interrupted linen Lembert sutures above and 2 below the point of entrance of the catheter. These sutures should be about ½ in. (1.25 cm.) apart and so applied as to infold a vertical ridge of the stomach wall. Tie the sutures and insert a second row, inverting the first row. A third row may be introduced if the stomach wall is thin and not contracted. The stomach wall, where the catheter emerges from it, is then sewed to the parietal peritoneum and posterior rectus sheath, as in the Stamm method.

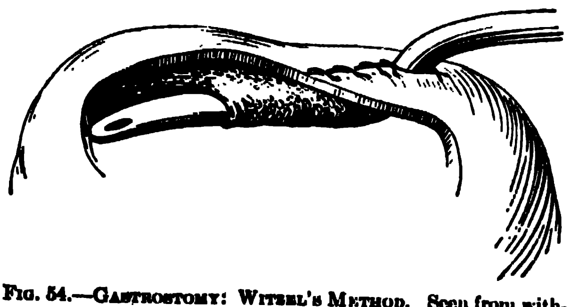


FIG. 54.—GASTROSTOMY: WITZEL'S METHOD. Seen from within stomach.

Witzel Method.—This method (Figs. 53, 54) aims at the establishment of an oblique fistula instead of a vertical one. Theoretically it should be better than the preceding methods. Actual experience has shown that in time the fistula loses its oblique direction and becomes vertical. It also requires more of the stomach wall for its performance and, therefore, cannot be so easily done on a small contracted stomach.

Make an incision 2 to 3 in. (5 to 8 cm.) long in the left rectus, pull out the anterior wall of the stomach, and find a point about midway between the curvatures and as near the cardia as possible, allowing for infolding of 1¾ in. (4.5 cm.) of the stomach wall to the left of this point. Make a small opening in the stomach wall and introduce a No. 25 F. catheter for 2 in. (5 cm.) into the stomach cavity. Fix the catheter with 1 or 2 catgut sutures. Lay the catheter on the anterior wall of the stomach and, with a continuous or interrupted linen Lembert suture, infold the catheter by suturing a ridge of the stomach wall over it for a distance of 1¾ inches (4.5 cm.), starting the suture well beyond the point of entrance of the catheter into the stomach, so as to bury this area. Suture the wall of the stomach where the catheter emerges to the parietal peritoneum and posterior rectus sheath. This forms an oblique tunnel out of the stomach wall.

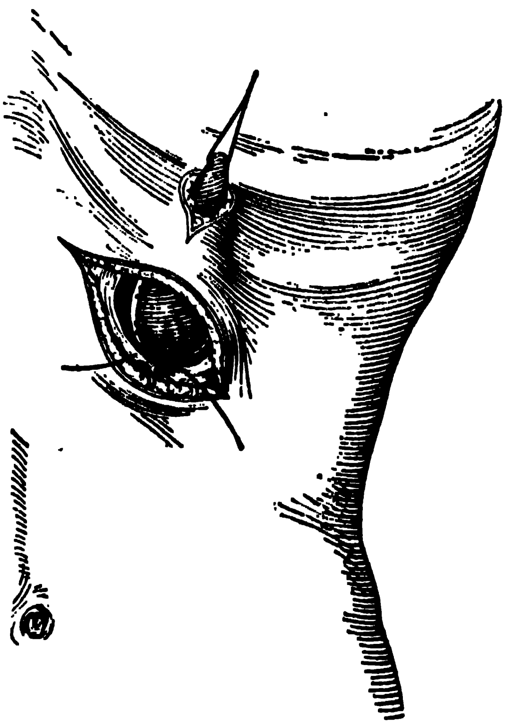


Fig. 55.—Gastrostomy: Ssabanejew-Frank Method. Cone of stomach wall pulled out from opening above. Stomach sutured to posterior sheath of rectus in lower incision.

Witzel has modified the original operation for the purpose of preventing this loss of obliquity of the canal, which, as stated above, occurs after a time. For this purpose, after making the vertical rectus incision, he makes the incision in the transversalis fascia horizontal, and sutures the infolded portion of the anterior stomach wall to the horizontal opening in the fascia, thus endeavoring to maintain the oblique direction of the fistula.

Marwedel's method of performing gastrostomy is a modification of Witzel's, the catheter lying between the muscular and mucous coats in the wall of the stomach instead of forming a canal by infolding the entire thickness of the stomach wall. In addition, the parietal peritoneum is sutured to the skin.

Ssabanejew-Frank Method.—Make a skin incision 3 in. (7.5 cm.) long parallel to the left costal margin, and 1 in. (2.5 cm.) below it. Divide the left rectus

muscle and sheath vertically and pull out a cone of the stomach from as near the cardia as possible. See that the area pulled out is sufficiently long, without tension, for the following procedure: Insert a traction suture in the apex of the stomach cone. Undermine the skin to a point above the costal margin. Make a small incision over this point and pull the apex of the cone of the stomach through this opening without tension. Suture the stomach wall of the base of the cone to the parietal peritoneum and posterior rectus sheath. Suture the rectus muscle and anterior sheath from below upward, leaving the upper part of the stomach cone passing between the upper separated rectus fibers above for sphincteric action. Close the skin of the first wound. Make a small opening in the apex of the stomach cone and suture the edges of the opening to the skin.

Kocher modified this method by retracting the rectus muscle outward instead of splitting its fibers, and then using the Witzel method of inserting the catheter instead of pulling out the apex of the cone of the stomach wall above. The objection to the Frank method is the amount of stomach wall employed, it being impracticable in a small contracted stomach.

Other Methods.—Other methods of performing gastrostomy have been devised, such as the older methods of Hartmann, Torrier and Jaboulay, in which a cone of the stomach wall is pulled under a bridge formed by splitting the left rectus and the apex of the cone is sutured to the skin, the rectus muscle acting as a sphincter. As this method has been superseded by better ones, it will not be described in detail.

Tavel (40) has made use of a loop of jejunum, which he has isolated. He has left its mesentery attached, restored the continuity of the bowel, sutured the distal end of the isolated loop to the stomach wall and the proximal end to the skin. This method has been employed for the formation of the lower part of a new esophagus by Lexer, Fragenheim, Roux and Wullstein.

Jianu (18) has made use of the greater curvature of the stomach to construct the lower portion of a new esophageal tube, and Willy Meyer has successfully performed his operation several times (22).

It would hardly seem advisable to make use of these methods instead of the simpler ones, except that they may be done as a preliminary operation to the resection of an esophageal growth, with the purpose of forming a new esophagus.

OPERATIONS FOR GASTROPTOSIS: GASTROPEXY

Indications.—The necessity of operative treatment for the cure of any cases of gastroptosis is disputed by a number of internists and gastroenterologists and a number of surgeons. Moynihan, Binnie, and others believe that the gastroptosis is only a part of a general visceroptosis and, as Moynihan says, "not the most important part of a more widespread disorder." It is conceded that many of the cases can be relieved by non-surgical treatment. Rest in bed with the foot of the bed elevated, forced feeding with small quantities of food of high nutritive value frequently administered, lavage when necessary, medical gymnastics, the wearing of properly applied abdominal bandages or corsets, will often result in causing the relaxed stomach wall to regain its lost tone and function, with consequent relief of the symptoms caused thereby.

In the severe cases, especially of the "water-trap stomach" types, that do not respond to non-surgical treatment and in those cases where the prolonged treatment necessary cannot or will not be carried out in the detail necessary for success, operation does effect a cure. The reports of Coffey, Beyea, Rovsing, Duret and many others prove this to be so, and personal experience with the operative treatment of this condition has convinced me of the excellent immediate results to be obtained, and a number of patients that I have been able to follow have been free from a return of symptoms for a period of from 1 to 3 years after operation. The ptosis itself should not be the indication for operative treatment, but the failure to cure by other means the symptoms caused by the ptosis, such as stasis, both gastric and colonic, vomiting, eructations of gas, constipation, malnutrition, intestinal toxemia, etc., should justify a surgical procedure.

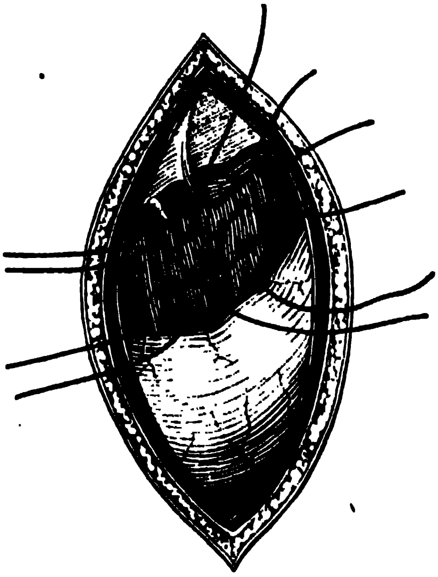


Fig. 56.—Gastropexy: Beyea's Method. Sutures inserted in gastrohepatic omentum.

The methods of performing gastropexy are either the direct, in which the stomach is sutured to the anterior abdominal wall, as in the methods of Rovsing and Duret, and the indirect, in which the suspension is performed by means of the gastrohepatic or the gastrocolic ligaments of the great omentum, as in the methods of Beyea and of Coffey.

Beyea's Operation (Fig. 56).—Make an incision 4 in. (10 cm.) long in the median line midway between the ensiform and umbilicus, retracting upward and exposing the gastrohepatic and gastrophrenic ligaments, forming the lesser omentum. With chromic gut sutures on a curved needle, plicate in a horizontal direction the lesser omentum, bringing up the lesser curvature of the stomach and fastening it under the liver. Avoid injury to the blood-vessels when inserting the sutures. Beyea, in his description of the operation, employs 3 rows of silk sutures. The great difficulty in the successful performance of the operation in some cases is the texture of the gastrohepatic ligament, which may be exceedingly thin in its central portion. It is thicker and heavier at each end and near the liver. Eve passes the sutures below through the lesser curvature of the stomach anterior to the vessels and, if the posterior part of the gastrohepatic omentum is thin, passes the sutures through the substance of the liver just anterior to the transverse fissure.

Coffey's (8) Hammock Operation (Fig. 57).—Make a median epigastric incision 5 or 6 in. (12.5 to 15 cm.) long. The technic of the operation depends on the degree of ptosis and relaxation found. Its essential part consists in the suture of the great omentum to the anterior abdominal wall. The interrupted chromic gut mattress sutures should extend to the left side as far as possible, thus lifting up the left end of the greater curvature where the ptosis is greatest. Seven or 8 sutures about 1 in. (2.5 cm.) apart and picking up the gastrocolic omentum, or both the great omentum and gastrocolic omentum below and above the transverse colon, are attached to the anterior abdominal wall transversely on a line about 2½ inches (6.25 cm.) above the umbilicus. Thus, by means of the adhesions formed, a hammock is made, suspending the stomach. In addition, Coffey shortens the gastrohepatic ligament, as in Beyea's operation, as well as shortening the falciform ligament if hepaptosis is present.

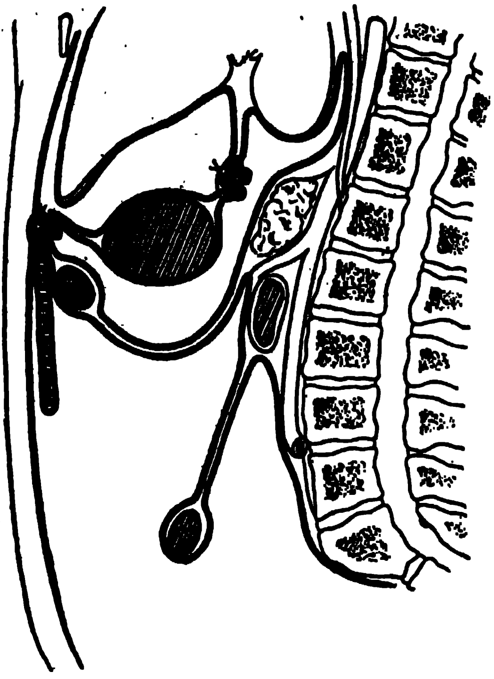


Fig. 57.—Gastropexy: Coffey's Method. Diagram showing shortening of gastrohepatic omentum, and suspension of stomach and colon by suture of gastrocolic and great omentum to anterior abdominal wall.

Rovsing's Operation (Fig. 58).—This operation aims at the direct adhesion of the anterior stomach wall to the abdominal wall. Below is Rovsing's own description of the operation.

"Parallel with the lesser curvature I lead three strong silk threads in and out through the serous coating of the anterior surface of the stomach, leaving the pyloric portion free. The upper thread is placed close under the lesser curvature and the two others with an interval of about 2 cm. are placed in such a way that the greater curvature and a rather large piece of the wall above this are left free. With a fine needle the serous coating between the threads is now scarified in all directions, also the surface of the parietal peritoneum, and eventually that part of the under side of the liver to which one wishes the stomach to adhere. The ends of the silk threads are led out through the entire thickness of the abdominal wall, that on the left as far as the site of the rib curvature, that on the right about 3 cm. to the right of the center line. The peritoneum is now joined with catgut and the fascia and skin with aluminum bronze, and after the line of the wound has been closed with collodion and cotton wool, the silk sutures are tied over a glass plate covered with sterile gauze, the dimensions of which are a little larger than the stomach surface which has to be fixed. The silk threads are left for four weeks and are then easily removed."

Rovsing also shortens the gastrocolic ligament, as coloptosis accompanies the gastroptosis and contributes to the symptoms.

Duret's Operation (Fig. 59).—This was the first operation performed for gastroptosis in 1897. A median incision is made from the ensiform to the umbilicus, dividing all the layers in the lower half, but not the peritoneal layer in the upper half of the incision. A stout silk suture, starting externally through the peritoneum, passes alternately through the peritoneum and lesser curvature of the stomach from left to right, the ends being passed through the muscular layers and tied subcutaneously.

Choice of Operation and Results.—Rovsing's (36) personal statistics, as a result of 163 cases, showed 50.6 per cent. cures, 14.7 per cent. greater improvement, 11 per cent. improvement, and 12.8 per cent. slight improvement or none. The mortality was 4.9 per cent.

The results of the same operation in 93 cases in the hands of other Scandinavian surgeons showed 75.2 per cent. cured, 9.6 per cent. improved, 11.8 per cent. slight improvement or none, and a mortality of 3.2 per cent.

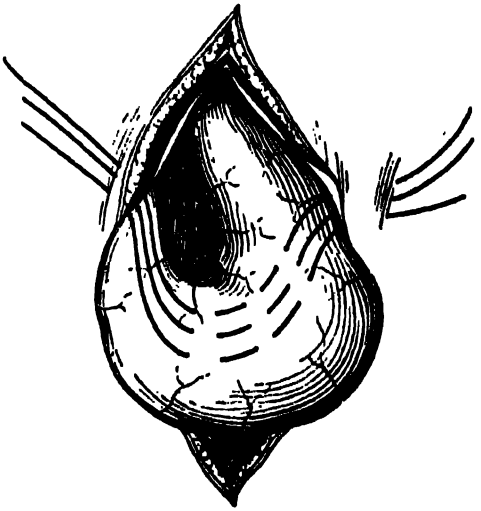


FIG. 58.—GASTROPEXY: ROVSING'S METHOD. Three rows of linen sutures inserted in stomach wall and emerging from skin of abdominal wall.

Coffey (8), reporting on 41 cases, states that 26 were symptomatically cured, 9 very much improved, 4 somewhat improved, 1 unimproved (had tuberculous enteritis), and 1 died of pneumonia.

The simplest operation which promises a permanent cure of the symptoms with the least danger to the patient and the minimum interference with the normal physiological action of the stomach is the one to be chosen. If the gastrohepatic omentum after plication were always sufficiently strong to continue to maintain the weight of the stomach, Beyea's operation would be ideal, but it is frequently thin and easily stretches. However, combined with suture of the gastrocolic omentum over a wide area to the anterior abdominal wall, as in Coffey's method, which supports the ptosed transverse colon as well as the stomach, good results are obtained. I have now employed this method in 10 cases. The immediate result was excellent in all. In one case with a general visceroptosis, in which double nephropexy, as well as gastropexy was performed, the patient returned to heavy work 6 weeks after operation without a supporting bandage or corset, such as all these patients should wear for a time. A radiograph taken 1 year later shows that the stomach has again become ptosed but to a lesser degree than before operation; also, it empties promptly, while previously there had been a residue 6 hours after the bismuth meal. Symptomatically the patient is much improved.

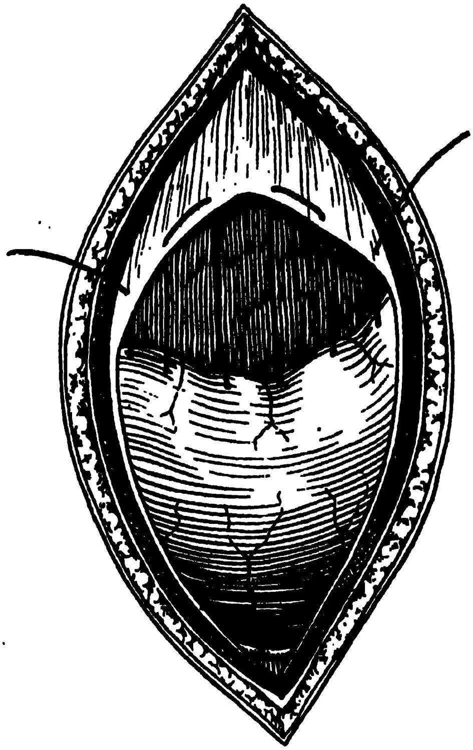


FIG. 59.—GASTROPEXY: DURET'S METHOD. Heavy silk suture passes alternately through lesser curvature of stomach and parietal peritoneum. Sutures are not yet passed through muscular layer of abdominal wall as is done before tying.

The other cases operated on during the past 3 years have so far been cured or greatly improved and have gained in weight, but a sufficient time has not as yet elapsed to determine the permanency of the relief of their symptoms.

Rovsing states that the ptosis recurs after the Coffey operation, due to stretching of the adhesions and to the stomach sagging down to the left side of the area of omentum sutured to the abdominal wall. The latter can be avoided by wide retraction and carrying the sutures well over to the left along the greater curvature.

If permanent results can be obtained by this simple method, there would seem to be little necessity for performing posterior gastrojejunostomy, accompanied by pyloric occlusion, as advocated and performed by a number of surgeons in the treatment of gastroptosis, and certainly none for such a radical procedure as a "wedge-shaped resection of the median part of the stomach," as practiced and advocated by Schlesinger (37).

GASTROPLICATION

The first plication of the anterior wall of the stomach was reported by Bircher (5). Bircher's operation consisted in the suture of 2 distant points on the greater curvature of the stomach to corresponding points higher up: the right point to one on the lesser curvature, the left point to one higher up on the fundus. Thus a fold consisting of most of the anterior stomach wall was made to extend into the stomach.

The operation is also performed by the insertion of a number of running seromuscular sutures vertically through the anterior stomach wall. These, on being tied, plicate it in segments.

As the stomach is a muscular organ and dilatation is due to obstruction or to atony of its musculature, this operation is not curative. It is, therefore, rarely if ever indicated.

CARDIOSPASM

The operative treatment of cardiospasm by means of dilatation from below, after a gastrotomy has been performed, has been largely replaced by stretching of the lower end of the esophagus by means of dilators of the type devised by Gottstein (13) and by Plummer (32), introduced through the mouth down to the constricted spasmodic area. These dilators consist of a silk-covered rubber balloon which can be filled with water under pressure and regulated as desired, and dilatation can be accomplished without the necessity of a cutting operation.

Previous to the introduction of this type of instrument, Mikulicz (27) had performed gastrotomy and dilated the cardia and lower end of the esophagus by means of a rubber-covered clamp introduced through the stomach incision. Later he obtained the same result by dilatation with the fingers introduced through the cardia. Cardioplasty, after the method of the Heinecke-Mikulicz pyloroplasty, has also been suggested, but has little to recommend it, and if, as has been suggested, the obstruction is in the lower esophagus as it passes through the esophageal opening in the diaphragm rather than at the cardiac orifice itself, such an operation would be useless.

Cardiospasm is frequently accompanied by a dilatation of the esophagus above the point of constriction. When this dilatation is fusiform in shape and the axis of the esophagus is not changed, the dilatation of the constriction allows drainage. In a few cases, however, there is also an elongation of the esophagus, resulting in an Ƨ curve (Reversed S). Lambert (19) has successfully treated a case of this kind by drawing the redundant, dilated pouch of the esophagus through the diaphragm and then introducing a large, heavy clamp through a gastrostomy wound, one blade passing through the cardia into the dilated esophageal pouch, the other blade remaining in the stomach. On closing the clamp, the contiguous surfaces of the esophageal pouch and stomach were brought together and surrounded with chromic catgut sutures. The edges of the enlarged opening of the diaphragm were then sutured to the esophagus. The clamp was allowed to remain in place for 4 days without being disturbed, when it was tightened to its full extent, thus crushing the included tissue. It was removed on the ninth day, the patient being fed by a gastrostomy opening through which the handle of the clamp protruded.

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DIAGNOSTIC RÖNTGENOGRAPHY OF THE ALIMENTARY CANAL

CHAPTER III

DIAGNOSTIC RÖNTGENOGRAPHY OF THE ALIMENTARY CANAL

LEON THEODORE LEWALD

No more fitting introduction to this important subject can be found than the following remarks made by that martyr to the Röntgen ray, Dr. Charles Lester Leonard:

"The importance of röntgenography in the diagnosis of gastro-intestinal lesions has recently been emphasized by the prominence given to this subject in the programs of national medical and surgical societies.

"Special reports have been made and entire sessions given over to their discussion. The progress of the past five years has influenced medical and surgical opinion until a Röntgen examination is considered a *sine qua non* before operation.

"The kindred sciences of anatomy, physiology, and pathology show the effect of their study in the living man by this method. Other methods of physical and chemical diagnosis are not displaced, but are amplified by the knowledge it affords. In fact, the Röntgen method yields its best results when the patient referred for examination is accompanied by all the data which the older methods can secure" (Leonard, 104).

THE TEETH

Certain lesions of the teeth and jaw may be accurately diagnosed by means of the Röntgen ray.

Unerupted Teeth.—Of first importance are unerupted wisdom teeth. Numerous cases of reflex nervous disturbances have been traced to unerupted teeth and recovery has resulted after their location and removal.

Abscesses at the roots of teeth are a fruitful source of systemic poisoning. In all cases of chronic joint trouble of unknown origin a careful search of all the teeth may reveal an unsuspected abscess, the drainage of which, either alone or combined with a vaccine treatment based upon a culture from the abscess, may result in a complete cure. (Rönt. I.)

Salivary deposits and calculi may also be located by the Röntgen ray.

THE PHARYNX

Retropharyngeal abscess may be diagnosed by means of the Röntgen ray.

Foreign Bodies.—Foreign bodies in the pharynx should not be removed until their exact location has been ascertained by Röntgen examination whenever this is possible. This is particularly true of a pointed metallic body, such as an open safety-pin. For, once the exact size, shape, and position have been ascertained, the exact procedure for removal can be worked out in advance and all preparations made.

THE ESOPHAGUS

Foreign Bodies.—Foreign bodies of sufficient density can be accurately located in the esophagus. In cases of doubt a small amount of bismuth mixture may be swallowed and the body more clearly located by the coating of bismuth which it will receive. Great care must be used in doubtful cases not to render a negative opinion as to the presence of a foreign body until a most exhaustive search under favorable circumstances has been made. The whole esophagus, not merely one part, must be searched, the patient must be kept quiet, and the exposures made instantaneously and in various directions. Even then, as Dr. Chevalier Jackson says, "Always keep a string on your negative statements as to the presence of a foreign body."

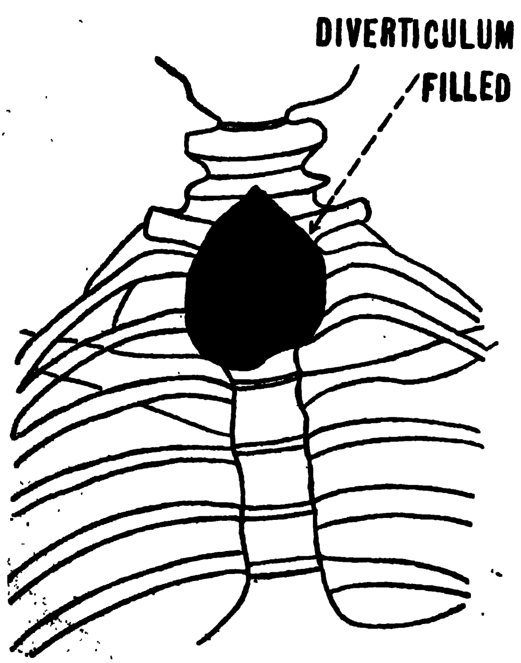


FIG. 1.—DIVERTICULUM OF ESOPHAGUS. Bismuth mixture has filled the diverticulum and remained there after the remainder of the food had passed down into the stomach. Tracing from a röntgenogram. (Operation by Dr. W. A. Downes.)

In cases of supposed obstruction in the upper end of the esophagus a spasmodic condition may exist or the condition may be part of a glossolabiolingual paralysis. New growths may occasionally be diagnosed in this region. Esophagoscopic examination should supplement the Röntgen examination in doubtful cases.

Diverticula.—A diverticulum may be found at the upper portion of the esophagus, and demonstrated by its filling with a bismuth mixture which has been swallowed. Anterior and lateral views are necessary to determine the size of the pouch (Fig. 1).

Diverticula may also be found at the lower end of the esophagus, but the condition here is more apt to be a dilatation secondary to spasm, as the esophagus passes through the diaphragm, the so-called cardiospasm.

Cardiospasm.—In cardiospasm the meal readily passes down to the cardia, where it stops. Fluoroscopically, it may be seen to ascend and be churned back and forth in the esophagus. The patient at this time usually experiences his characteristic discomfort, and will often state that if he is given a glass of water or may be allowed to exert some peculiar muscular effort—such as leaning against the wall—he will be relieved. If a radiographic examination is then made, one may find that the entire bismuth meal has passed out of the esophagus into the stomach. This is the characteristic point to observe in searching for cardiospasm. The Röntgen shadow is also quite distinctive in this condition, as contrasted with the irregular shadow due to a new growth (Rönt. V). Lateral or oblique projections are better for this purpose than anterior or posterior projections. One gathers the impression that there may be some mechanical factor which accounts for cardiospasm. In doubtful cases a more or less solid meal must be combined with the bismuth. Pineapple cut into small pieces and mixed with bismuth in the proportion of 1 ounce (30 gm.) of bismuth subcarbonate to 6 ounces (180 gm.) of pineapple has been found satisfactory for this purpose. Verification by means of an esophagoscopic examination is always desirable.

Strictures from swallowing caustics may be accurately located and an idea of their caliber ascertained.

Congenital Anomalies.—Congenital anomalies of the esophagus may be diagnosed positively. Among the most common anomalies is esophagotracheal fistula. In 62 cases collected by McKenzie, 43 had communications with the air passages. It is very important in these cases to know the exact anatomical condition present, for gastrostomy affords little or no relief unless the *cardiac* end of the stomach is closed; if the lower end of the esophagus communicates with the trachea, food will be regurgitated from the stomach into the air passages. In many cases of congenital anomalies the esophagus ends in a blind pouch. There may be a fibrous cord extending from it to the cardiac end of the stomach, and from the cardiac end of the stomach, extending upward, a patent esophagus opening into the trachea near the bifurcation. A case of this sort was correctly diagnosed by Dr. E. B. Truesdell, and reported by Dr. J. R. Losee (119). (See Rönt. XXXI.)

Transposition of the viscera may be suggested by finding that the esophagus runs in a course opposite to that usually followed. In my experience transposition of one viscus invariably means that others also are transposed. (See Rönt. III.)

New Growths.—New growths may be accurately diagnosed, and their size.

extent, and exact site determined. They are most commonly encountered in the middle portion of the esophagus; next in frequency, at the cardiac end; and least frequently, in the upper third at about the level of the sternal notch. In differentiating this condition from tuberculosis and syphilis it is often necessary to combine the Röntgen findings with laboratory reports, supplemented by an esophagoscopic examination, and removal of a section for microscopic examination.

According to Dr. William H. Stewart, the radiographic technic in making these examinations consists in giving a thick paste of either a cupful of well-cooked cream of wheat or boiled potatoes, in which has been thoroughly mixed one ounce (30 grams) of subcarbonate of bismuth. The patient, if possible, is fed ¾ of this mass, the idea being to fill the usually dilated esophagus above the constriction to its full capacity. The quantity, of course, must necessarily vary with the amount of dilatation that is present. The patient is then laid upon the table in what is commonly known as the left posterior oblique position, that is, lying on the plate, with the back turned halfway toward the left side. The ray is directed squarely to the chest, centering to the right side at about the middle line. The patient, being placed in the proper position, the plate beneath and the tube above, the last quantity of the bismuth-impregnated mixture is given, with instructions that it be retained in the mouth until the patient is directed to swallow it. Everything being in readiness, the patient is instructed to swallow the mouthful, and to hold his breath. This is sometimes difficult, but, by proper instruction, can be readily accomplished by an intelligent patient. As soon as the patient swallows the mass and holds his breath, an exposure is made. Stereoscopic röntgenograms are advisable. In doubtful cases a rubber bag or sausage skin, closed at the lower end, may be swallowed by the patient—or introduced by the operator—and then filled with a bismuth mixture. In this way the esophagus may be accurately outlined, and its contour studied röntgenographically. A positive Röntgen diagnosis of tumor of the esophagus can usually be made at an early stage, if the patient is examined with the proper technic. (See Rönt. II.)

THE STOMACH

Congenital Anomalies.—In the cases of so-called non-rotation of the colon the stomach shows a departure from the normal in the pyloric end and the junction with the duodenum. A failure to observe this has in 2 cases which I have seen, in which the radiographic examination was limited to the stomach alone, led to error in diagnosis, and in 1 case to a laparotomy for supposed stomach or duodenal lesion requiring surgical intervention, which was in reality unnecessary. (See Rönt. XXII.)

Transposition of the Stomach.—I have observed transposition of the stomach 8 times, in every case combined with complete transposition of all the thoracic and abdominal viscera. The stomach in this type of case is located on the right side in a position which corresponds exactly to the position which it would have upon the left side in the normal individual. So true is this that, if one simply turns the Röntgen negative over, the shadows correspond absolutely with those of a normal subject. This emphasizes the necessity of the röntgenologist making it an invariable rule to have plate markers so attached to the apparatus that automatically with each exposure the words "right" and "left" are impressed on the radiograph. Otherwise a case might easily be overlooked under the impression that the plate or intensifying screen had been reversed. (See Rönt. III and compare with Rönt. XII.)

So true is it that in transposition of one viscus the others are also transposed, that I have found it a safe rule in cases of displaced heart shadow to determine whether the case is one of true transposition by relying upon the position of the stomach as determined by means of a bismuth meal, or sometimes simply by the outline of the cardiac end of the stomach as shown by its usual gas content.

Hour-glass Deformity.—This most interesting and striking condition of the stomach can be diagnosed positively by the Röntgen ray. In the words of Hertz: "The diagnosis of hour-glass stomach is rightly regarded as one of the greatest triumphs of radiography."

The cases, however, fall into two groups: first, the functional hour-glass stomach (Figs. 2 and 3), and, second, the true type (Figs. 4 and 5).

FUNCTIONAL HOUR-GLASS STOMACH (76).—A spasmodic constriction may be present at the Röntgen examination and absent at surgical operation. This is usually due, nevertheless, to an ulcer on the lesser curvature of the stomach, or in some other part of the stomach or duodenum. The ulcer in this type of case may be only superficial and cannot be felt on palpation of the stomach wall even after opening the abdomen. In case of doubt the stomach must be examined from inside as well as from outside, as only the mucous membrane may be involved.

The differential diagnosis may be established by the administration of atropin, which may relax the spasm. Vigorous abdominal massage may also produce a relaxation of the spasm. But the simplest of all procedures, namely, an examination in various positions, especially prone and standing, should never be omitted. A second examination on another day may show the condition to have disappeared. (See Fig. 2.)

HOUR-GLASS STOMACH DUE TO ADHESIONS.—This condition may be determined in some cases by noting a variation in the constricted area, as observed by me in one case in which the neck of the constricted area shifted from the region of the lesser curvature to a point nearer the greater curvature. Laparotomy revealed a firm band of omentum being held by adhesions to the liver. The band crossed the stomach about its middle. (Rönt. VII.)

ORGANIC HOUR-GLASS STOMACH.—This condition, so long considered by

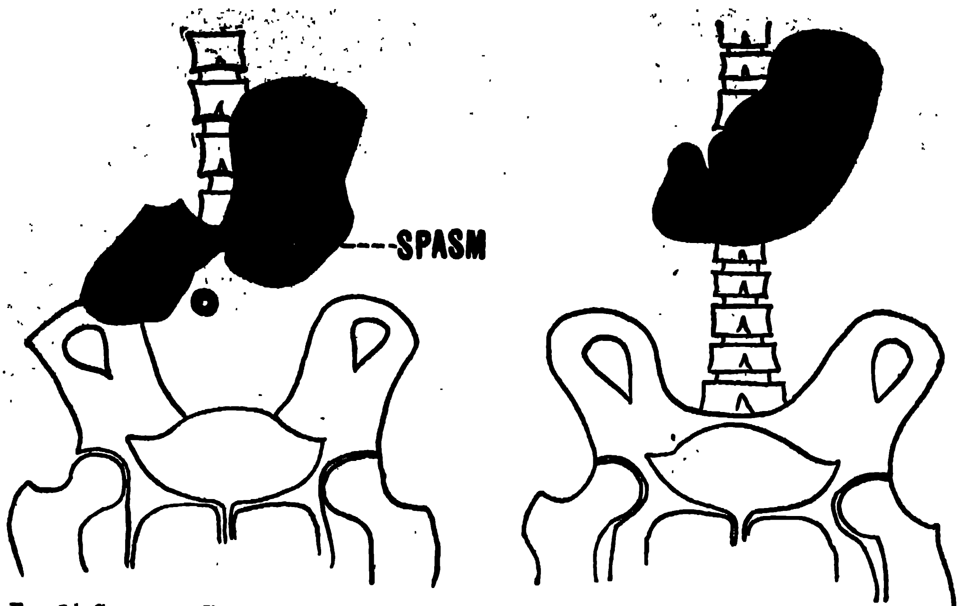


Fig. 2.—Spasmodic Pseudo Hour-glass Stomach. At operation no ulcer could be made out. On manipulation the spasmodic condition of the stomach disappeared. The patient was cured of her vomiting attacks. Röntgen examination showed that the spasm never returned. Second illustration shows the stomach after operation. (Operation by Dr. H. H. M. Lyle.)

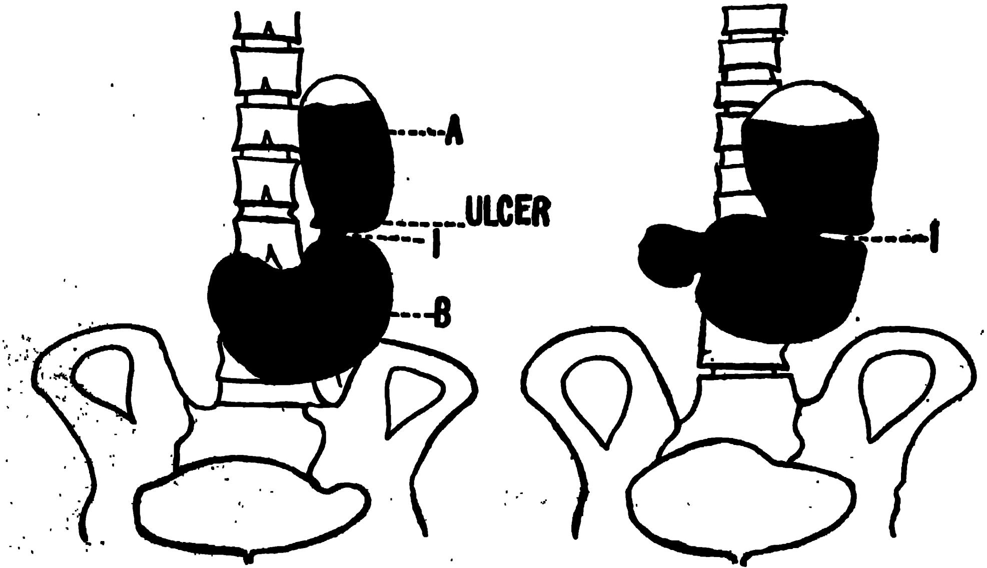


Fig. 3.—Penetrating Ulcer at Lesser Curvature of Stomach. *Spasmodic constriction* causing *hour-glass-like* appearance. At operation the spasm disappeared. The ulcer was excised. Note that the spasmodic constriction recurred. This shows the desirability of resecting the entire ulcer-bearing section of the stomach when practicable. A, Upper pouch; B, lower pouch; I, incisura. The second illustration shows the stomach after operation. (Operation by Dr. W. A. Downes.)

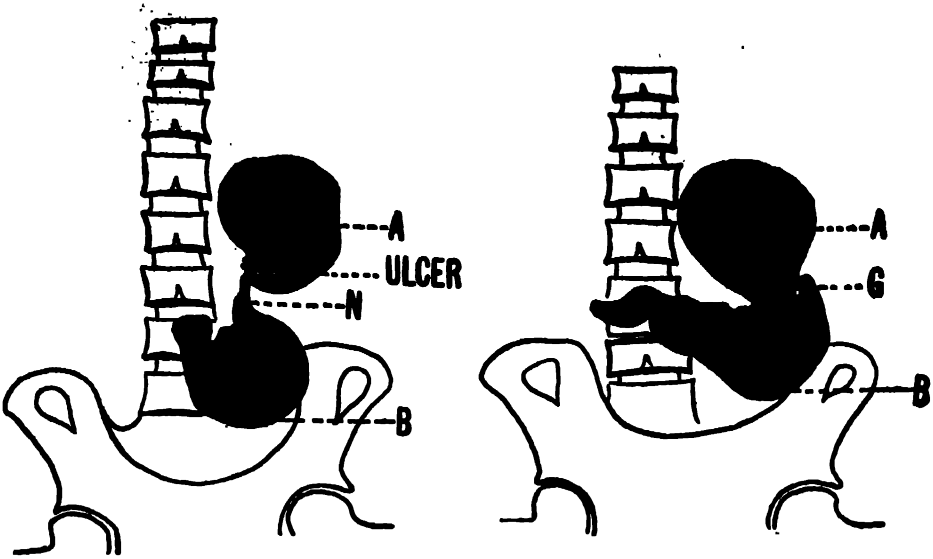


FIG. 4.—HOUR-GLASS STOMACH. True type due to organic deformity from penetrating ulcer, with adhesions to the liver. Resection impossible. *Gastrogastrostomy* performed. Perfect functioning after operation. A, Upper pouch; B, lower pouch; G, after gastrogastrostomy; N, neck between pouches. (Operation by Dr. W. A. Downes.)

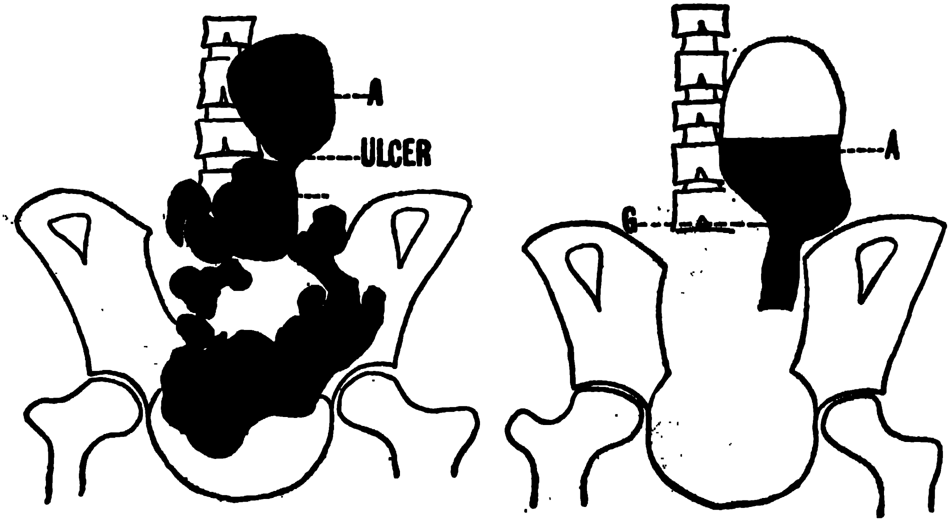


FIG. 5.—ORGANIC HOUR-GLASS STOMACH. Ulcer at lesser curvature. *Gastro-enterostomy* using the upper pouch was successfully performed. A, Upper pouch; G, stomach after gastro-enterostomy. (Operation by Dr. W. A. Downes.)

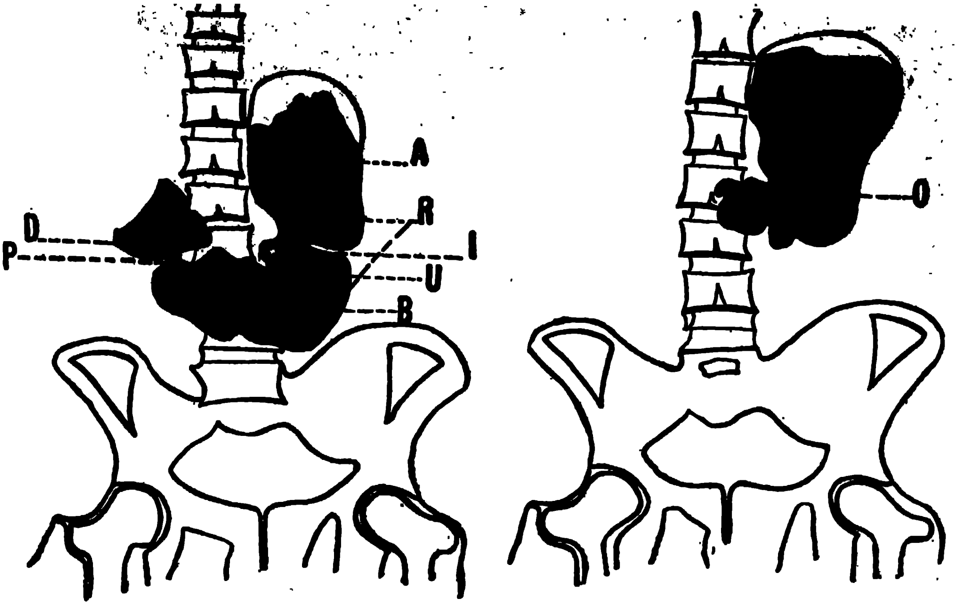


Fig. 6.—Penetrating Ulcer at Lesser Curvature of Stomach. Spasmodic constriction at greater curvature causing pseudo hour-glass appearance. Ideal operation was performed—complete resection of ulcer-bearing and spasmodic area. Excellent functioning of stomach after operation. A, Upper pouch; B, lower pouch; D, duodenum; I, incisura; O, stomach after operation—mediogastric resection; P, pylorus; U, ulcer which penetrated into pancreas. (Operation by Dr. W. A. Downes.)

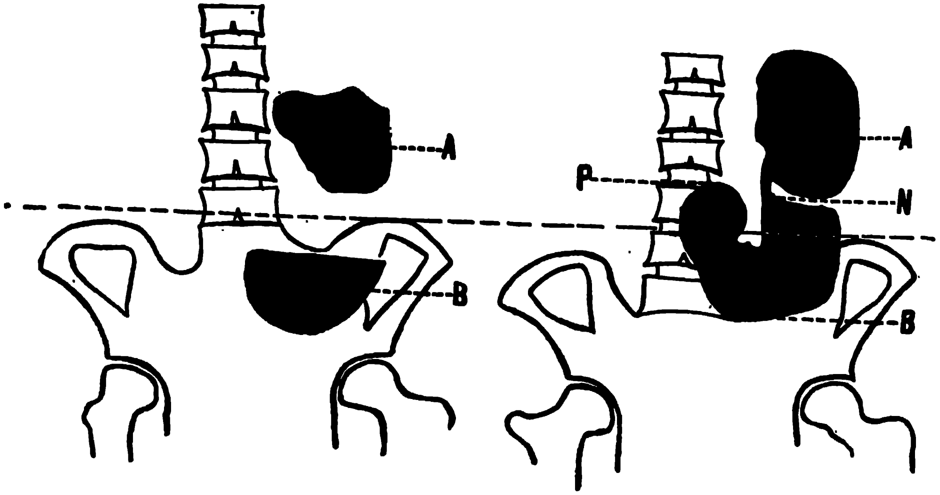


Fig. 7.—Hour-glass Stomach, True Type, Due to Cicatrized Ulcer at Lesser Curvature. Note in the vertical posture no connecting neck observed, while in the prone position in addition to the neck coming into view there is observed a *spasmodic closure of the pylorus*. This spasm disappeared at operation (gastrogastrostomy, see Fig. 4) but recurred later, showing that gastroenterostomy to the upper pouch alone or in addition to the gastrogastrostomy might have been done to the lower pouch to circumvent this spasm. A, Upper pouch; B, lower pouch; N, neck; P, spasm at pylorus. First figure shows vertical position; second figure shows prone position.

many as congenital (an opinion which I shared as a pathologist, at a time when I presented such a specimen before the New York Pathological Society) has now been positively determined to be always of pathological origin, usually due to ulcer originating on the lesser curvature. (Rönt. VI.)

The Röntgen examination, after determining the organic nature of the deformity, should not rest there. The röntgenologist must go further, and must determine the exact size and shape of both pouches, the time it takes each pouch to empty, whether or not any other lesion, such as ulcer, is present in some other part of the stomach or duodenum, and the condition of the remainder of the intestinal tract. On the accuracy of his findings the kind and extent of operative procedure will largely depend. If he has overlooked a pyloric stenosis (even though it be only spasmodic) and the surgeon performs only a gastrogastrostomy, the result will not be a complete cure. Likewise, if the surgeon operates without a Röntgen examination having been made, or without due consideration of all aspects of the findings, the best results may not be obtained. In fact, the closest coöperation between the röntgenologist and the operator is essential to the securing of the best results. It is even wise, if possible, for the röntgenologist to be present at the operation, in order that his opinion may be obtained on doubtful points which may arise in complicated cases. (Figs. 4, 5, 7.)

HOUR-GLASS DEFORMITY DUE TO NEW GROWTH.—This condition may occasionally be encountered. It may be distinguished by the irregular contour made by the new growth (Fig. 8).

HOUR-GLASS DEFORMITY DUE TO PRESSURE FROM WITHOUT THE STOMACH.—This condition may be distinguished by the change with changing position of the patient, by manipulation under the fluoroscopic screen, etc. (See Rönt. VII.)

Syphilitic Deformity of the Stomach.—Two cases of this sort have been encountered. Both were in very young individuals approaching the age of adolescence, and were apparently of congenital origin. Both gave marked serum reactions. One case had such marked stenosis of the middle portion of the stomach as to require gastro-enterostomy, using the cardiac pouch of the stomach. So small was the cardiac pouch, however, that even after gastro-enterostomy, a compensatory dilatation of the esophagus persisted and limited the amount of food ingested at one meal to about 1/3 of that taken by the average individual of that age. But by frequent small feedings the patient has finally gained in weight and is cured. (See Rönt. IV.)

The other case had less stenosis and has, under antisyphilitic treatment, retained his weight and so far has not required the performance of a gastro-enterostomy. Three other cases have been called to my attention.

New Growths.—Certain diagnosis of new growth can be made in a large number of cases long before any tumor can be palpated. Every case showing gastric symptoms of whatever kind lasting more than a few weeks, or characterized by recurring attacks of gastric disturbances, even though the attacks are of but short duration, should have the benefit of a careful Röntgen-ray examination by a competent röntgenologist. In a recent case where the symptoms had only been present about 6 weeks the Röntgen examination revealed extreme gastric stasis. An immediate operation revealed an inoperable new growth of the duodenum. An earlier examination and operation might have saved this patient.

I have a number of cases under observation who are well several years after the excision of new growths diagnosed early by means of the Röntgen rays. The Röntgen diagnosis takes precedence over all other methods of diagnosis in this distressingly frequent site of cancer. While a negative opinion cannot always be expressed, nor a differential diagnosis always be made between ulcer of the stomach and early new growth (as might be expected when one acknowledges the frequency with which ulcer precedes cancer), the findings are always positive enough to indicate operative intervention. These statements are particularly true of growths at the pyloric end of the stomach. Another diagnostic method fortunately fits in here to fill out the gap that occurs in the diagnosis of tumors at the cardiac end and in the body of the stomach. I refer to gastroscopy according to the method of Dr. Henry Janeway. This procedure must be resorted to early in cases in which the clinical findings point to possible new growth and the Röntgen findings are negative or indeterminate.

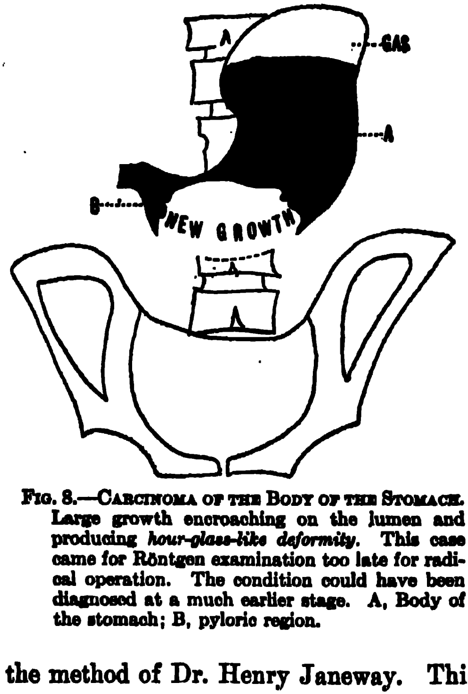


FIG. 8.—CARCINOMA OF THE BODY OF THE STOMACH. Large growth encroaching on the lumen and producing *hour-glass-like deformity*. This case came for Röntgen examination too late for radical operation. The condition could have been diagnosed at a much earlier stage. A, Body of the stomach; B, pyloric region.

In most cases I have found present both deformity of the contour of the stomach wall and failure of the stomach to empty itself. (Rönt. XI.)

New growths at the pylorus may cause extreme dilatation. Retention of food in the stomach showing traces of bismuth has been observed for as long a period as a week after the ingestion of a bismuth meal which had been followed by an examination at the end of 6 hours, during which time nothing had been taken into the stomach, but after which ordinary feeding had followed.

According to Carman, at the Mayo Clinic the Röntgen ray has shown diagnostic signs of carcinoma in 98 per cent. of the cases examined and proved to be carcinoma at operation. He lays great stress on the filling defect and arranges the signs in the following order, as to relative importance: "(1) Filling defect; (2) altered pyloric function—(a) gaping of the pylorus, (b) obstruction of the pylorus; (3) advanced position of the six-hour meal; (4) absence of peristalsis from involved areas of the wall of the stomach; (5) diminished mobility, loss of flexibility; (6) diminution in the size of the stomach; (7) antiperistalsis.

"The filling defect is a sign of cardinal import and is practically indispensable in the Röntgen diagnosis of carcinoma. It is occasioned by the projection of the tumor mass into the lumen of the stomach, and when filled with bismuth the visualized contour of the gastric lumen shows a corresponding irregularity. Obviously, filling defects vary in size according to the extent of the involvement. They also vary in appearance somewhat, according to the character of the cancer. The encephaloid (medullary) carcinoma produces large,—usually multiple, irregularities, while in the scirrhus type the indentations are very small, even absent, although the concentric narrowing may greatly lessen the caliber of the stomach, especially at the pyloric end, and give it a funnel or retort form, also diminishing its capacity. Invasion of the media by the growth may result in a marked hour-glass stomach, the loculi being united by a more or less tortuous canal.

"True filling defects must be carefully differentiated from indentations of the wall of the stomach by a gas-filled colon, by adjacent extrinsic tumors,—notably those of the liver, spleen, colon, and mesentery, and by spasm. The splenic flexure, in spite of preparation by purging, will often be distended with gas and give the adjacent greater curvature of the stomach a somewhat ragged aspect. By palpation during the screen examination, the stomach can be pushed away from the colon, causing this raggedness to disappear, or at least show its character. Filling defects caused by tumors external to the stomach, deforming its contour, are less easily differentiated. However, such filling defects may change in appearance with slight palpation, or even with respiratory movement. During the screen examination the intimate relation of a palpable tumor mass to the stomach and its correspondence to a filling defect in the gastric outline may sometimes be determined. The deformity produced by spasm, —most often the hour-glass,—is sharply delineated, in contrast with the usually indefinite shadings of a tumor-produced filling defect. Frequently it relaxes on energetic manipulation. Antispasmodics, such as belladonna, given for two or three days prior to a second examination, will generally cause such a spasm to disappear.

"In the cardia a filling defect may deform the normally regular gas bubble, the tumor outline showing more or less clearly. Examination of the patient recumbent, —in which position the cardia is more completely filled with bismuth,—may show such filling defects in stronger relief.

"Alteration of the pyloric function is an almost invariable acompaniment of gastric carcinoma, and may reveal itself in either of two quite opposite ways,—namely, free and continuous patency, or marked obstruction.

"In the carcinomatous stomach the pylorus,—whether because of actual stiffening by infiltration or by reason of lessened acidity of the gastric contents,—often remains gaping, and the bismuth ingesta flow freely and continuously through it.

"On the other hand, pyloric obstruction, varying in degree with the situation and size of the tumor, is also a common result of cancer. It is evidenced by a distinct, often large, residue from the six-hour meal.

"Obstruction may occur at any point in the lumen, from the cardia to the pylorus. An hour-glass stomach may show a six-hour residue in its upper loculus. High obstruction tends to dilatation of the esophagus, which may be quite marked in obstruction of the cardia. If there be no obstructive condition, the 'head,'—that is to say, the most advanced portion of the six-hour meal in the intestines, will occupy a position more or less proportionate to the degree of acidity. Ordinarily, at or near the cecum after six hours, it may be accelerated by the hypo-acidity incident to carcinoma of the stomach. In such cases it may be found anywhere from the hepatic flexure to the rectum, quite commonly in the transverse colon, or at the splenic flexure. While this phenomenon is, strictly speaking, only a gross measure of the acidity, it is an item of corroborative value.

"The peristalsis of a carcinomatous stomach often shows certain departures from the normal. Peristaltic vigor is generally proportionate to the degree of acidity, and as diminished acidity is a common accompaniment of carcinoma we often find in this latter condition a notable diminution in force and frequency of the peristaltic waves. However, in the case of recent pyloric obstruction the effort at compensation may show itself in quite vigorous contractions.

"More important is the interruption of peristaltic waves by carcinomatous infiltrations. A wave will progress to the affected area, skip it, and take up its course beyond.

"Lessened mobility occurs sufficiently often as a result of carcinoma invading adjacent structures,—thus more or less fixing the stomach,—to justify its inclusion in the important signs of cancer. Not rarely the fixation is extreme, and energetic manipulation will fail to alter the position of the stomach.

"Aside from the lessened mobility *en masse,* there may also be a notable loss of flexibility of the wall of the stomach, such that ordinary palpation has little effect on its contour.

"Anti-peristalsis,—i.e., peristalsis in the reverse direction,—has been noted in carcinoma by some radiographers.

"Accurately speaking, of course the question of malignancy is for the pathologist to determine with finality. However, the filling defects of carcinoma of the stomach are so characteristic radiologically that these cases can be diagnosed in 93 per cent.

"With reasonable care and a decent regard for the clinical facts, the Röntgen-ray findings will not only markedly enhance the percentage of correct diagnoses of cancer, but will also often furnish valuable information as to the advisability of operative intervention. For example, extensive involvement of the cardia, or of the media and cardia, renders surgical measures hopeless; while pyloric carcinoma offers a better prospect for surgical intervention, especially if there be no metastasis."

As to the röntgenologist's expressing an opinion as to the inoperability of certain tumors, I have never felt it justifiable to do this, in the face of the fact that certain cases have survived 5 or more years after surgical intervention and the performance of gastro-enterostomy, with the declaration of the surgeon that the patient could live only a few months.

Ulcer of the Stomach.—Some types of ulcer (penetrating) in certain locations (especially the lesser curvature) can be diagnosed with extreme accuracy. The characteristic finding is that of a bismuth-filled protrusion from the lesser curvature of the stomach. Very often, opposite the ulcer there will be a deep indentation of the greater curvature. This frequently gives an hour-glass-like appearance, and curiously enough the spasm may persist even after the excision of the ulcer, although at the time of the operation it appeared to have entirely relaxed. (See Fig. 3.)

Cicatrized ulcers at the pylorus give positive evidence of their presence and location. Deformity of the pyloric region (see Rönt. IX) and retention of the bismuth meal beyond 6 hours are the characteristic findings. Extreme dilatation of the stomach is often found in these cases, but yields readily to gastroenterostomy, as has been ascertained by checking many of these cases after operation.

The necessity of a standard method of examination has been urged by Carman, of the Mayo Clinic. "The value of the Röntgen ray as a diagnostic aid in gastric ulcer has in my opinion been greatly underestimated," he states.

> "Our technic may be defined as the combined fluoroscopic and skiagraphic examination with the double opaque meal. Barium sulphate is used in the six-hour meal, and at the time of examination the patient is given bismuth subcarbonate in water, followed quickly by bismuth subcarbonate in potato-starch pap.
>
> "As seen at operation, four classes of gastric ulcer may be distinguished: (1) small, exceedingly shallow mucous erosions and slit-like ulcers; (2) penetrating or callous ulcers with relatively deep craters; (3) perforating ulcers with or without accessory cavity formation; and (4) very early carcinomatous ulcers.
>
> "Of these four classes, the first,—the small, shallow, mucous erosions,—offer the greatest difficulty of röntgenologic detection. They are either superficial denudations or mere slits in the mucosa, incapable of holding enough bismuth to make a visable niche. Unless accompanied by an incisura or a six-hour rest their presence will hardly be even suspected, much less positively determined.
>
> "The penetrating ulcers which have burrowed more or less deeply into the gastric wall show a definite crater, which may be either quite round, oval, or irregular. The degree of facility with which the crater can be seen by the Röntgen ray as a niche depends upon its size and location.
>
> "Perforation of an ulcer and a continuation of the destructive process into an adjacent organ or tissue results in the formation of an accessory cavity. Those that I have seen were either in the liver or pancreas. None, shown later by operation, failed to be visible on screen and plate. Perforation may, of course, occur without the production of a pocket. In this event the radiologic signs are like those of callous ulcer, plus, in some instances, the distorting effect of adhesions.
>
> "The very early carcinomatous ulcers are not, as a rule, distinguishable macroscopically from non-malignant ulcer. Their röntgenologic signs are not different from those of penetrating or perforating ulcer.
>
> "The positive radiologic diagnosis of gastric ulcer can only be based upon the presence of one of two signs, namely: the niche, or the accessory pocket.
>
> "Other signs which are corroborative but not diagnostic of themselves are: (1) the incisura, (2) hour-glass stomach, (3) residue in the stomach after six hours, (4) lessened mobility, (5) localized pressure-tender point, (6) delayed opening of the pylorus, (7) acute fish-hook form of the stomach with displacement to the left and down, (8) gastric hypotonus, and (9) anti-peristalsis.
>
> "A distinct residue from the six-hour meal, amounting to an eighth or more of the quantity taken, is a relatively common accompaniment of gastric ulcer. Its most common cause is the pylorospasm which frequently accompanies ulcer, but in the case of an ulcer at or near the pyloric region obstruction from scar contraction may be responsible.
>
> "A six-hour rest is by no means an exclusive indication of ulcer, since it may occur in any obstructive condition, including carcinoma, duodenal ulcer, and pericholecystic adhesions, as well as reflex spasm from conditions outside the stomach.
>
> "The röntgenologic signs of ulcer differ so much from those of carcinoma in the

vast majority of cases that differentiation requires no effort at all. For example, a callous ulcer with niche and incisura, or a perforating ulcer with pocket-formation has no radiologic resemblance whatever to a well-developed carcinoma, either scirrhous or medullary, and such cases make up the bulk of those patients coming for Röntgen ray examination. In a general way ulcer defects always project from the gastric contour, while in carcinoma the growth with its resultant irregularity extends into or encroaches upon the gastric lumen. Between the typical ulcer and the typical carcinoma, however, there is a small percentage of cases in which röntgenologic differentiation is impossible. These are the border-line cases, in which carcinoma cells are found in the ulcer. In such instances the Röntgen signs are chiefly those of ulcer and such a diagnosis is likely to be rendered. At operation the nature of the lesion is usually not determinable macroscopically.

"Extreme size of an ulcer-crater as shown by a very large niche should make one suspicious of malignancy, a fact which I have had impressed upon me by experience. A niche three centimeters or more in diameter is apt to show microscopic sign of carcinoma.

"Differentiation of pyloric ulcer from pyloric carcinoma is most difficult. Here, in either event, the only radiologic signs may be a six-hour rest and an atypical irregularity of contour, and the röntgenologist can only say with certainty that a lesion exists.

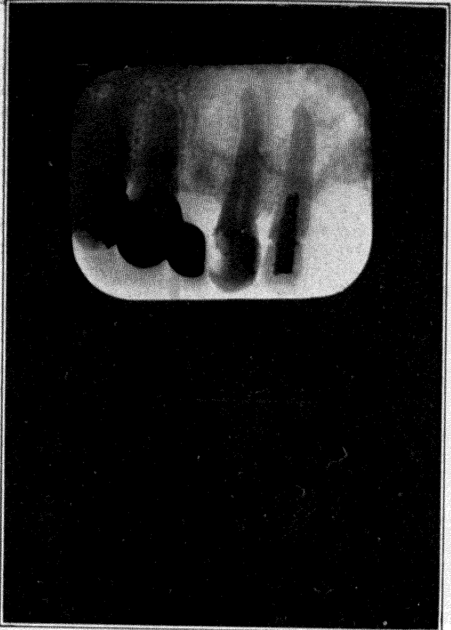
"In this analysis I have endeavored to emphasize the niche and the accessory pocket as being the only conclusive signs of ulcer. Next in order I would place the incisura, the hour-glass stomach and the six-hour residue. An incisura that has withstood the above mentioned test, occurring with a six-hour rest in the stomach, is, in the writer's opinion, sufficient evidence upon which to make a radiological diagnosis of gastric ulcer. This opinion would, however, be greatly strengthened if a second examination furnished the same evidence."

Foreign Bodies in the Stomach.—One of the most interesting, though rare, foreign bodies in the stomach is a hair-ball. In such cases the Röntgen findings are definite. I have encountered one case recently. (See Rönts. X and XII.)

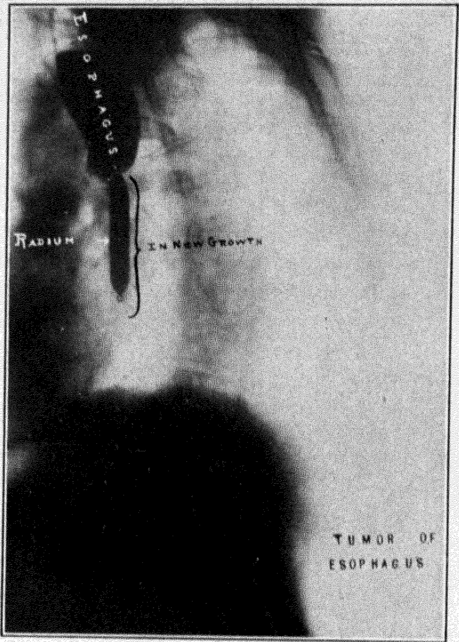
Such foreign bodies as coins, false teeth, Murphy buttons, etc., the immediate removal of which is not imperative, may be radiographed from day to day pending the possibility of their spontaneous passage into the intestinal tract.

Such foreign bodies as pointed metallic substances, needles, open safety-[illegible], etc., should be removed if repeated examinations during a few hours show that they cannot readily escape from the stomach. Very often immediate removal is the safest course.

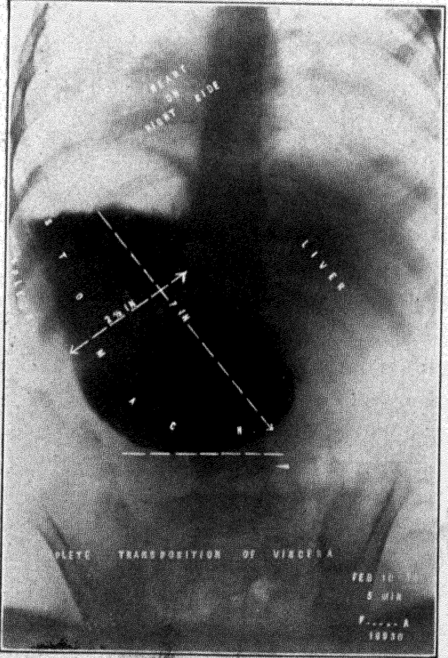
Water-trap Stomach.—This extremely interesting condition I have encountered several hundred times. It varies greatly in degree. Upon the Röntgen findings hinge the diagnosis and treatment. I would venture to state that water-trap stomach is as common in women as is inguinal hernia in men. The analogy also holds good as to degree and effect on the system. Just as many a hernia causes no trouble, so many a water-trap stomach is capable of emptying itself and so gives no symptoms. But, just as some hernias require a truss for relief of symptoms, so do some water-trap stomachs require [illegible] form of belt



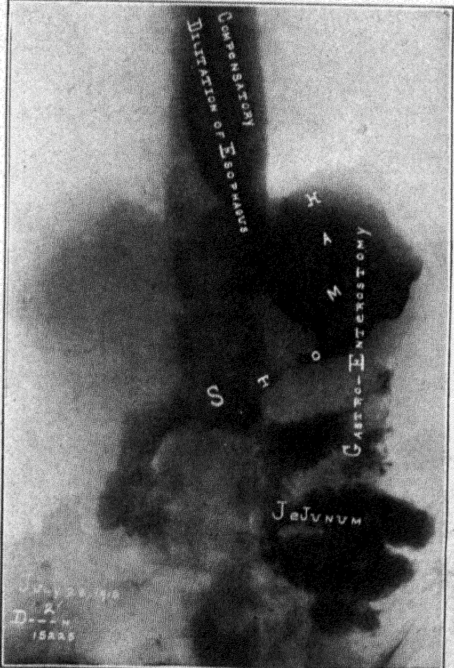
Rönt. I.—Abscess at Roots of Two Upper Teeth. Note the unfilled cavity through which infection has traveled to the root.



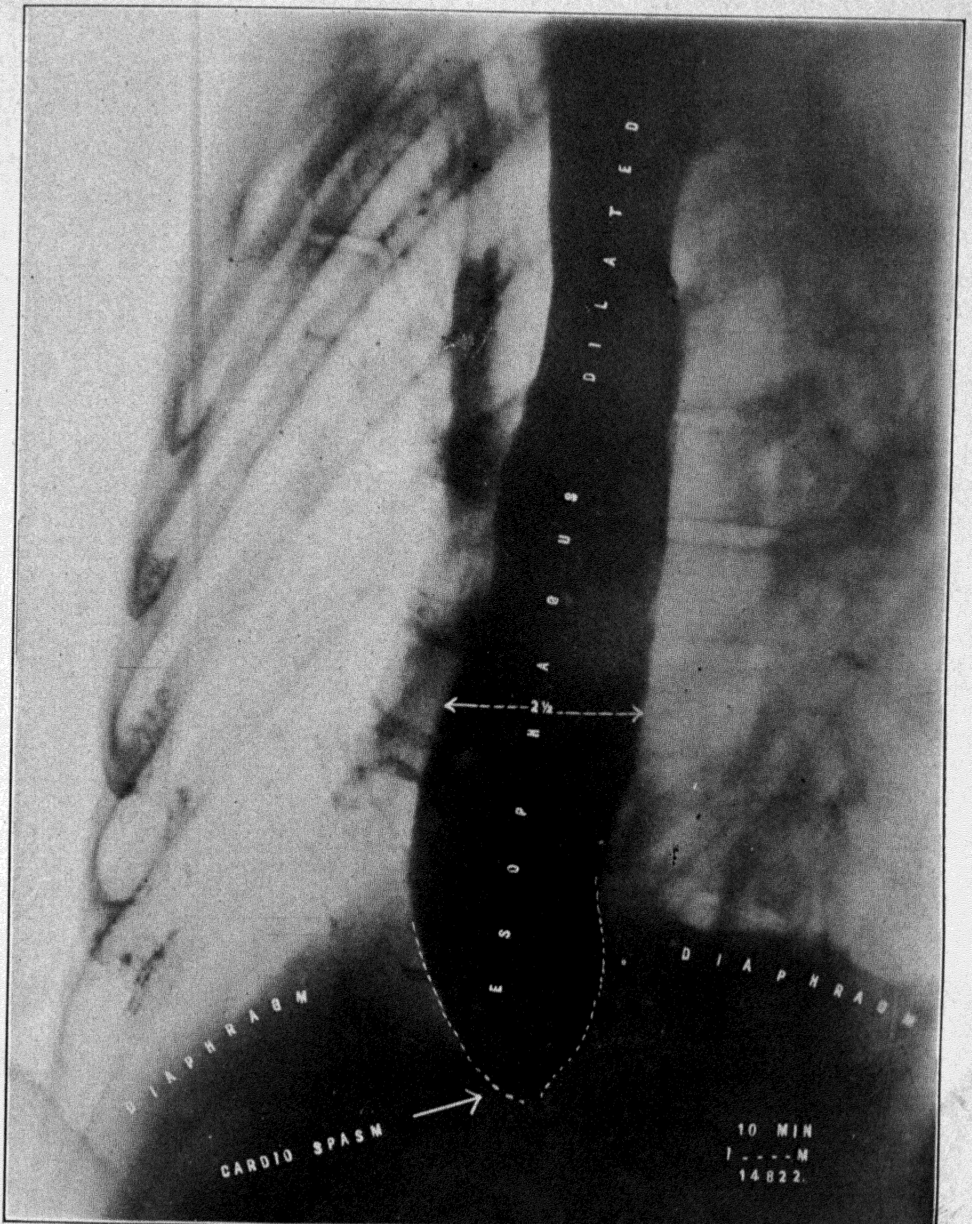
Rönt. II.—Carcinoma of Esophagus. Case under radium treatment. Correct position of radium demonstrated by Röntgen ray after administration of bismuth.



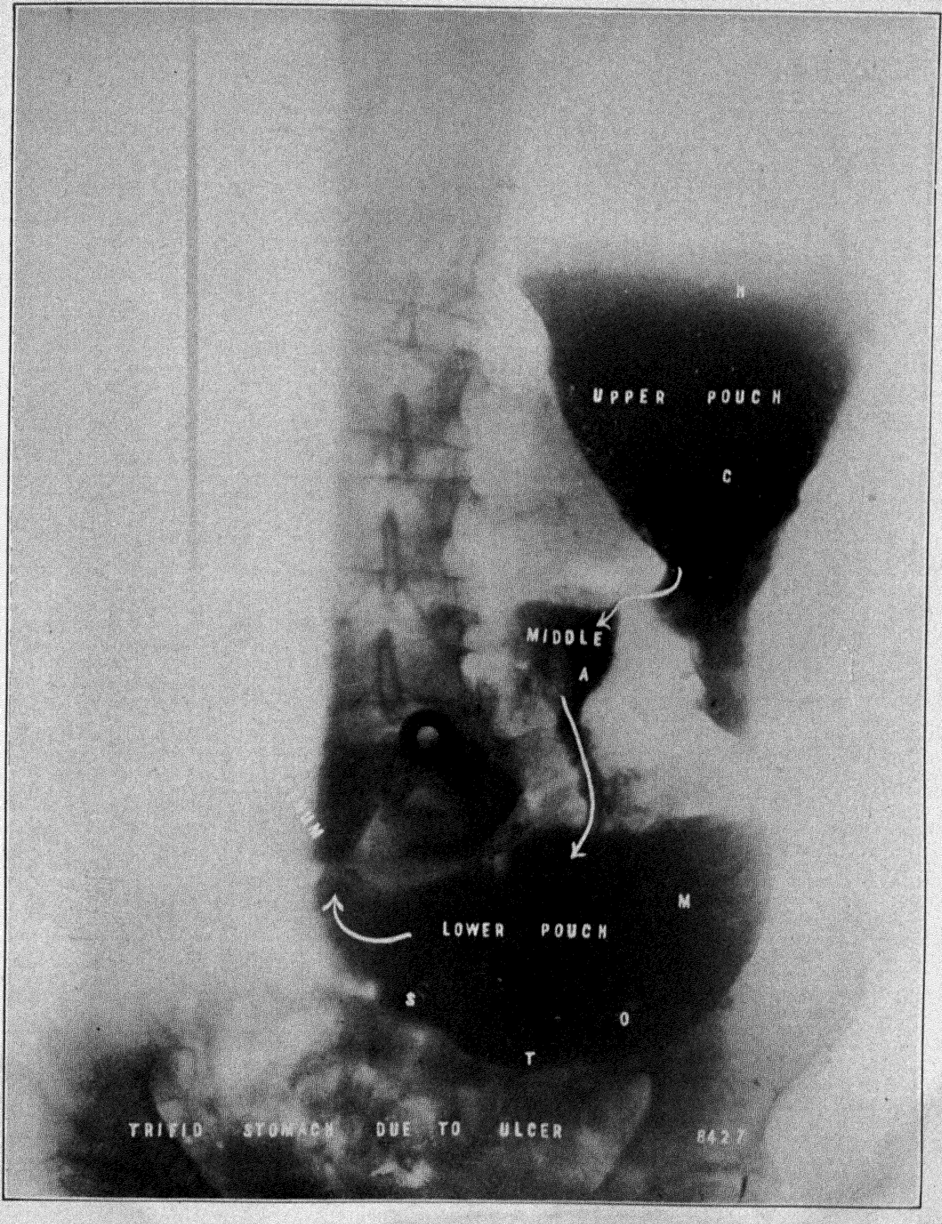
Rönt. III.—Complete Transposition of Viscera. Heart and stomach on right side.



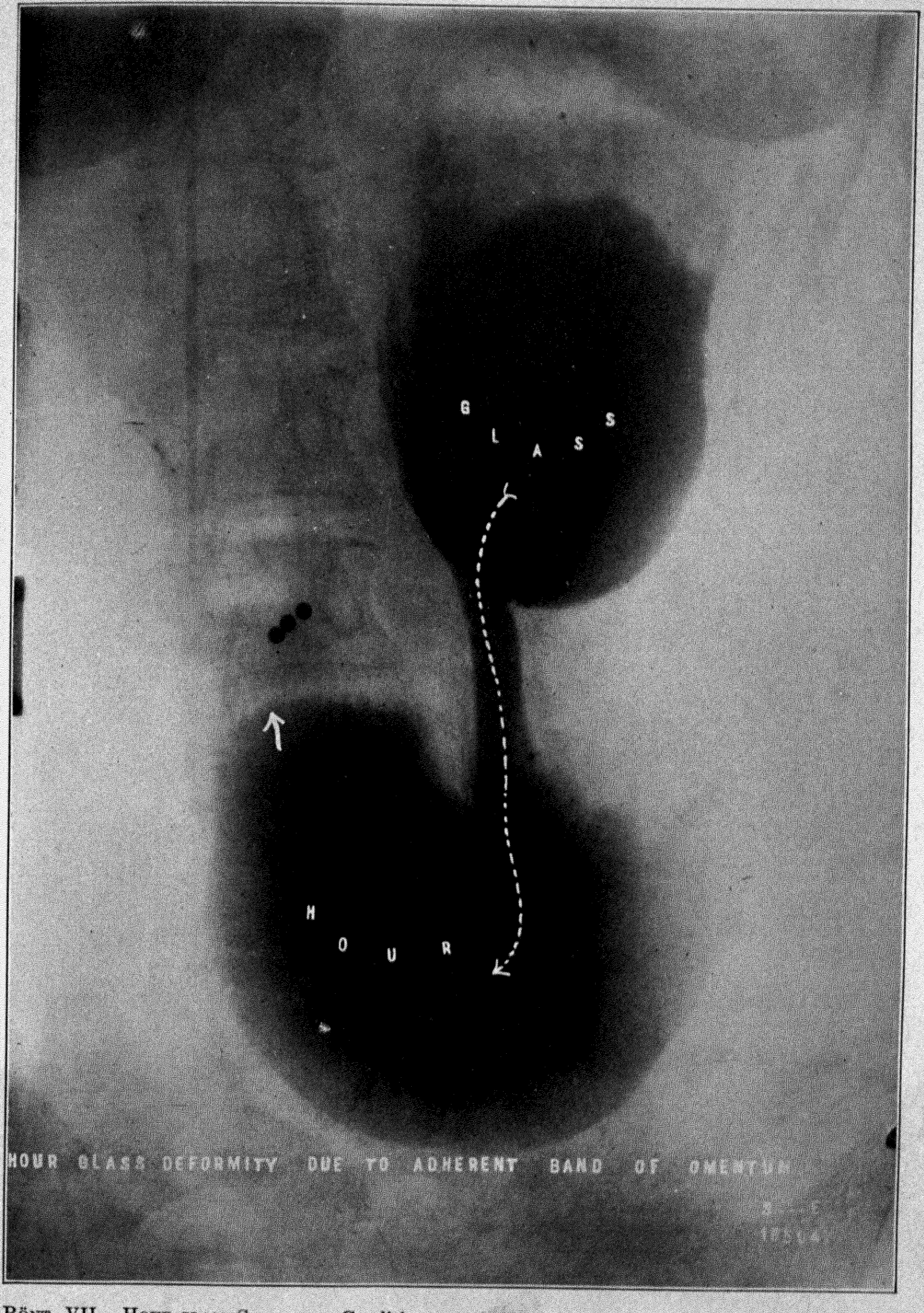
Rönt. IV.—Syphilis of the Stomach. Note the compensatory dilatation of the esophagus. Positive Wassermann reaction.



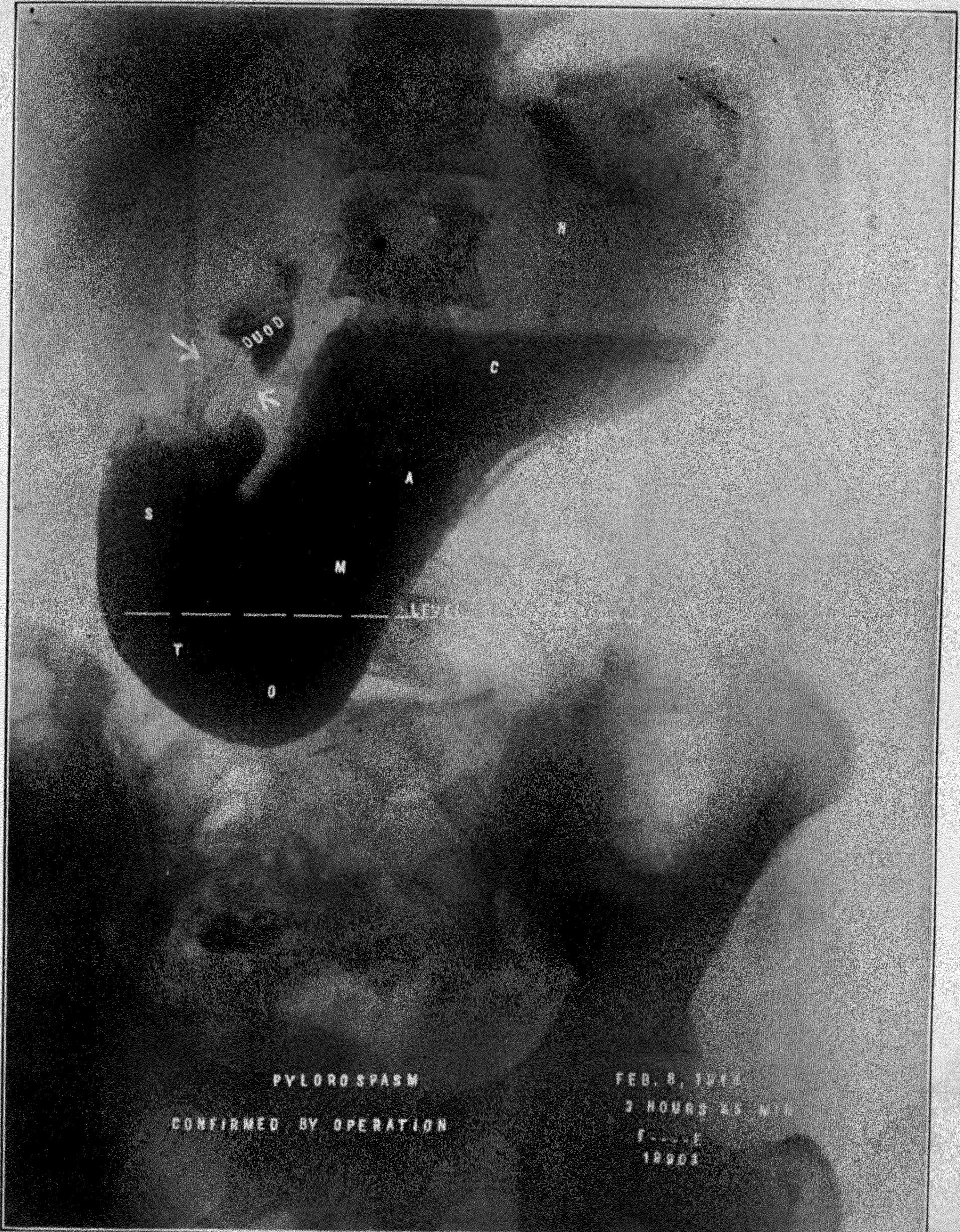
RÖNT. V.—CARDIOSPASM. Note the marked dilatation of esophagus. Male, aged 38. Symptoms have existed for 12 years. Spasm relaxes when the esophagus becomes filled to the very top.



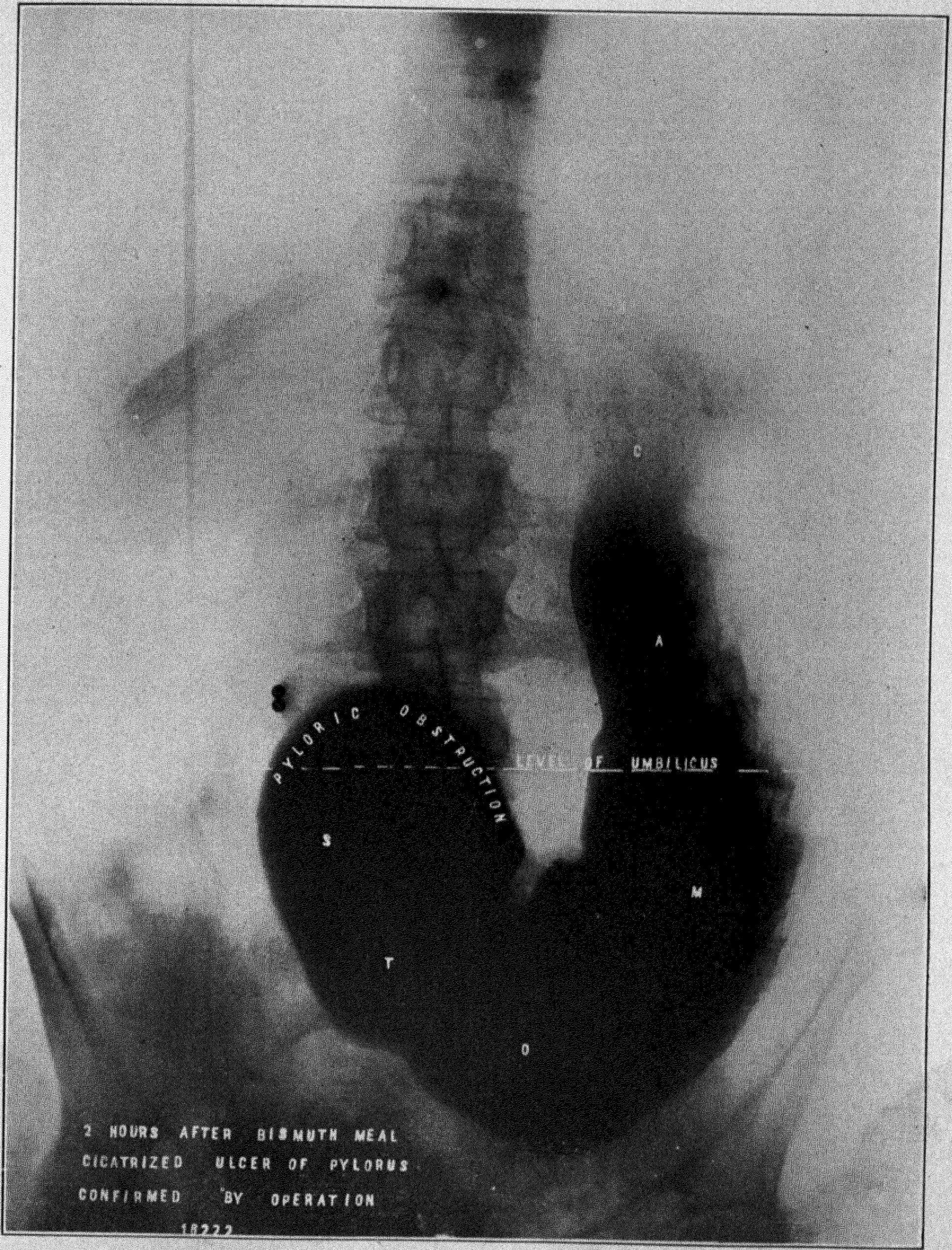
Rönt. VI.—Trifid Stomach. Extreme deformity of stomach due to ulcer. (Operation by Dr. C. L. Gibson.)



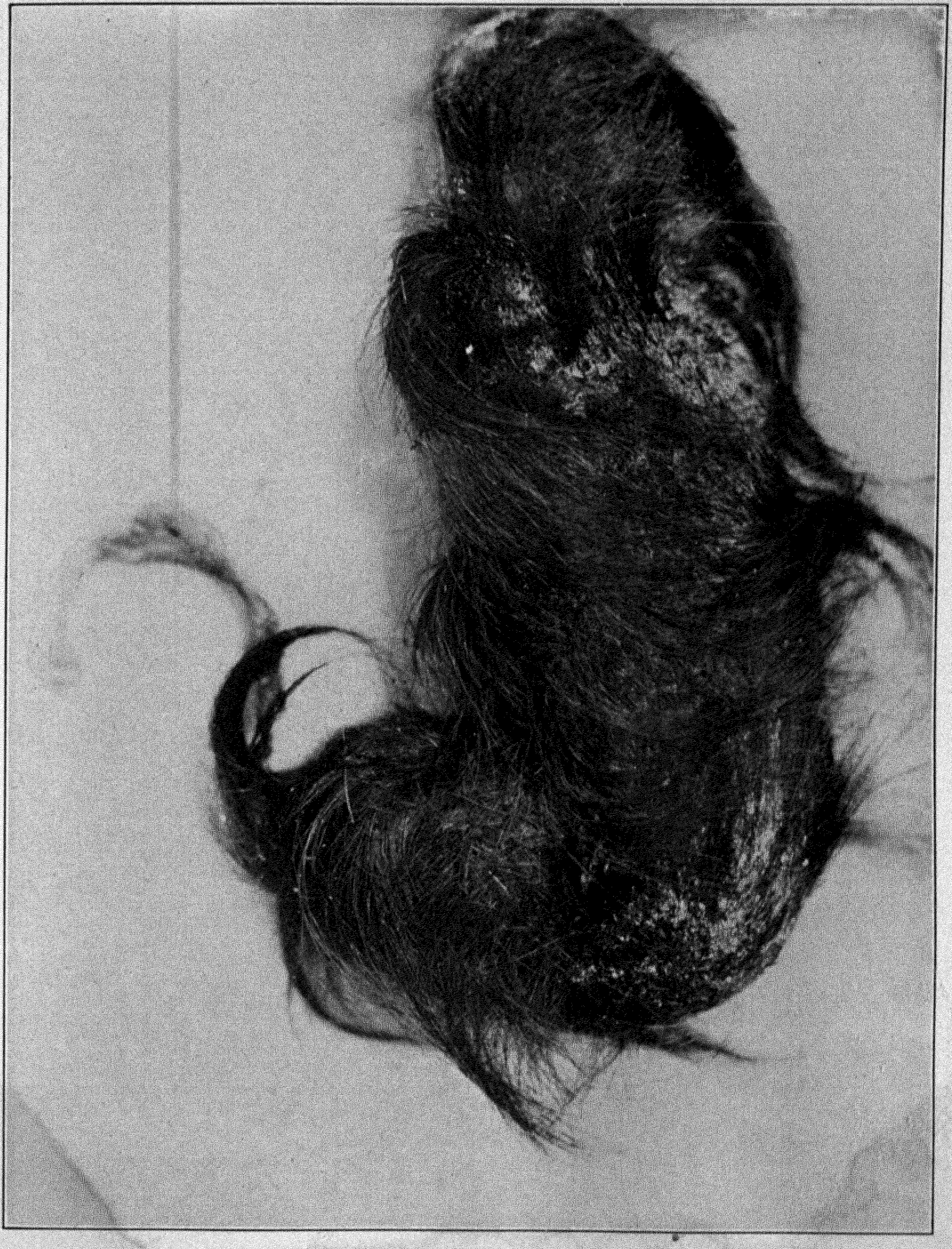
RÖNT. VII.—HOUR-GLASS STOMACH. Condition was due to adherent band of omentum crossing the stomach. (Operation by Dr. Walton Martin.)



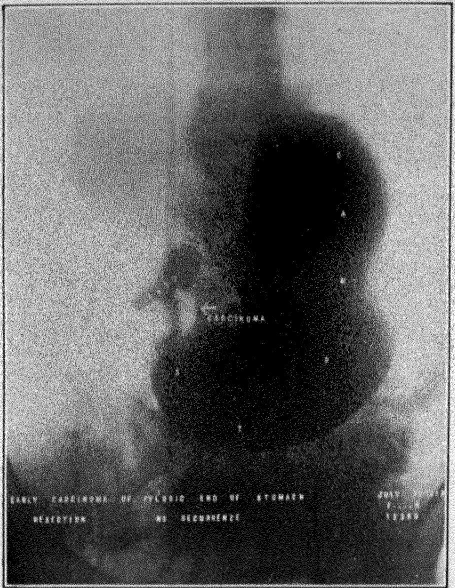
RÖNT. VIII.—PYLOROSPASM. Patient vomited for weeks. Only enough of the meal passed out of the stomach in 4 hours to outline the duodenal cap. Pyloroplasty. Complete recovery. (Operation by Dr. W. A. Downes.)



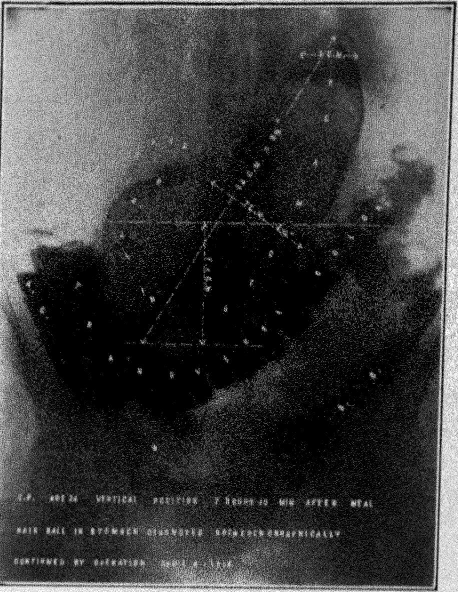
Rönt. IX.—Pyloric Stenosis Due to Cicatrized Ulcer. Dilated stomach. Residue for days. (Operation by Dr. J. M. Draper.)



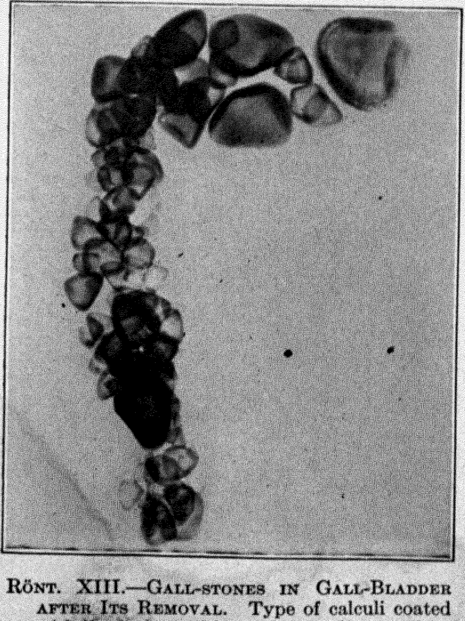
RÖNT. X.—HAIR-BALL AFTER REMOVAL FROM STOMACH. Note the perfect cast of the stomach. See Rönt. XII for appearance in the stomach.



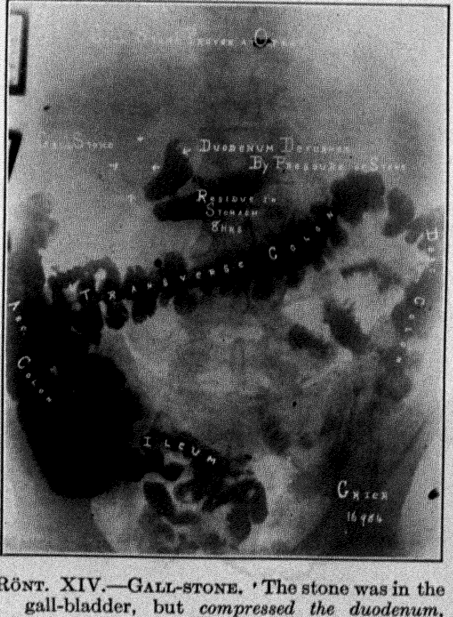
Rönt. XI.—Carcinoma at Pyloric End of Stomach. This case was diagnosed early enough for resection. No recurrence to date, one year. (Operation by Dr. Frank Mathews).


VERTICAL POSITION AFTER MEAL
HAIR BALL IN STOMACH DIAGNOSED ROENTGENOGRAPHICALLY
CONFIRMED BY OPERATION

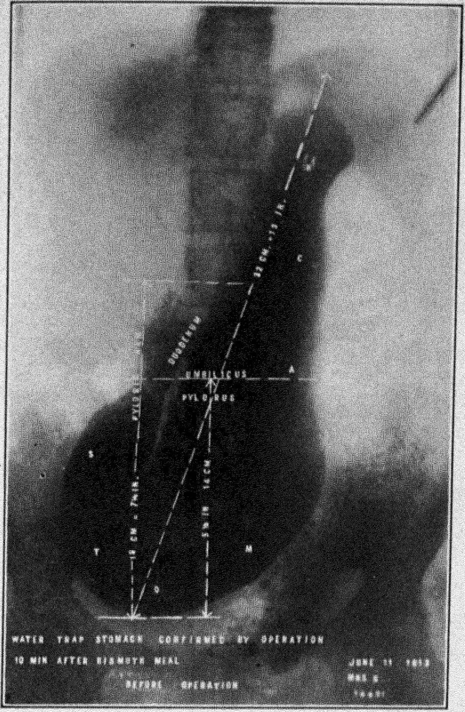
Rönt. XII.—Hair-ball in Stomach. Positive Röntgen diagnosis. See Rönt. X for appearance after removal. (Operation by Dr. Walton Martin.)



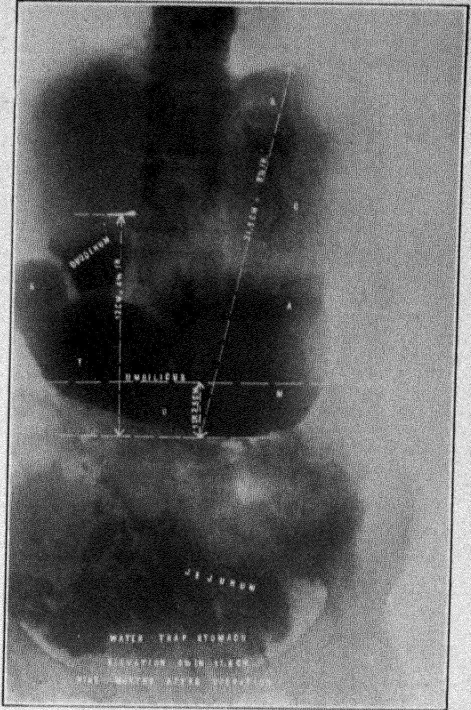
Rönt. XIII.—Gall-stones in Gall-Bladder after Its Removal. Type of calculi coated with lime salts and hence can be diagnosed by Röntgen-ray, which was done in this case prior to operation by Dr. G. E. Brewer.



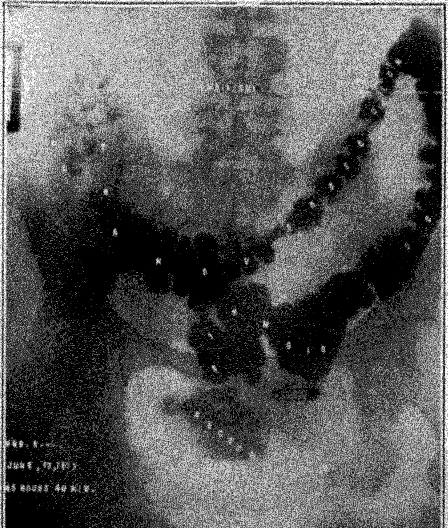
Rönt. XIV.—Gall-stone. The stone was in the gall-bladder, but *compressed the duodenum*, and *delayed the emptying of the stomach.* (Operation by Dr. John Douglas.)


DUODENUM
UMBILICUS
PYLORUS
WATER TRAP STOMACH CONFIRMED BY OPERATION
10 MIN AFTER BISMUTH MEAL
BEFORE OPERATION
JUNE 11 1913

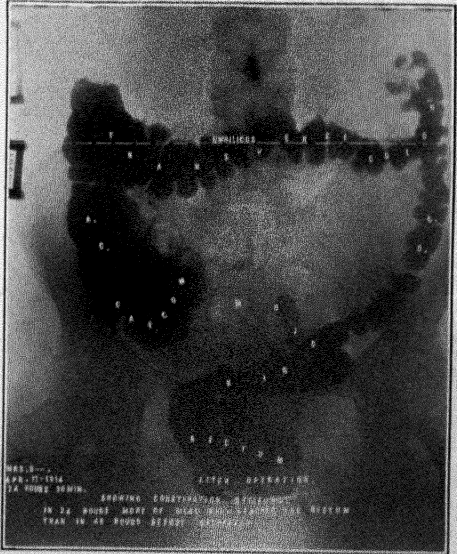
RÖNT. XV.—WATER-TRAP STOMACH BEFORE OPERATION. Greater curvature 5½ inches (14 cm.) below the umbilicus. Patient had suffered for years with "indigestion" and had given up all hope of being cured.



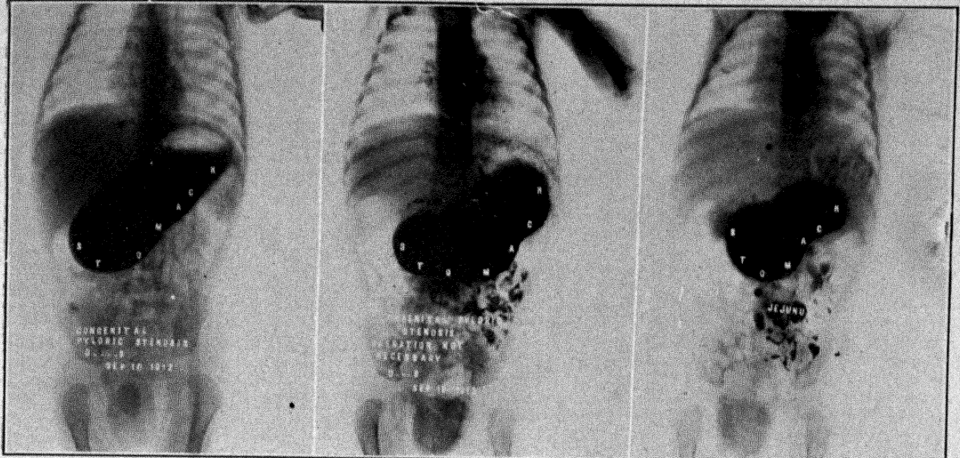
RÖNT. XVI.—WATER-TRAP STOMACH AFTER OPERATION. Nearly a year after suspension operation. Patient cured. Greater curvature remains at a normal level. (Operation by Dr. J. M. Draper.) See Rönt. XV.



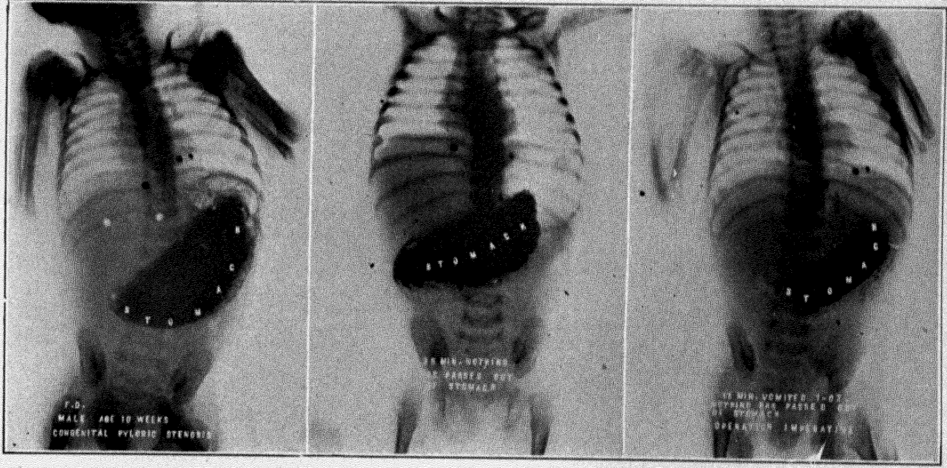
RÖNT. XVII.—PTOSIS OF THE COLON, BEFORE OPERATION. Constipation. For stomach in this case see Rönt. XV. (Operation by Dr. J. M. Draper.)



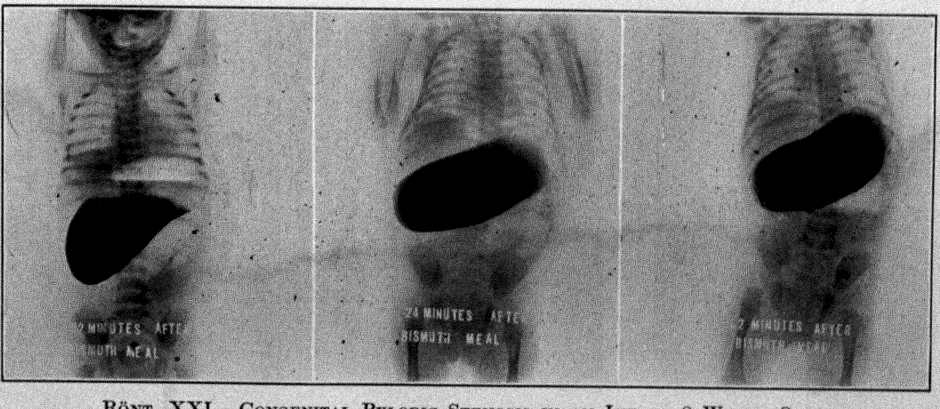
RÖNT. XVIII.—PTOSIS OF THE COLON AFTER SUSPENSION OPERATION. Constipation cured. Note: more of the meal has reached the rectum in *24 hours* than previously in 48 hours.



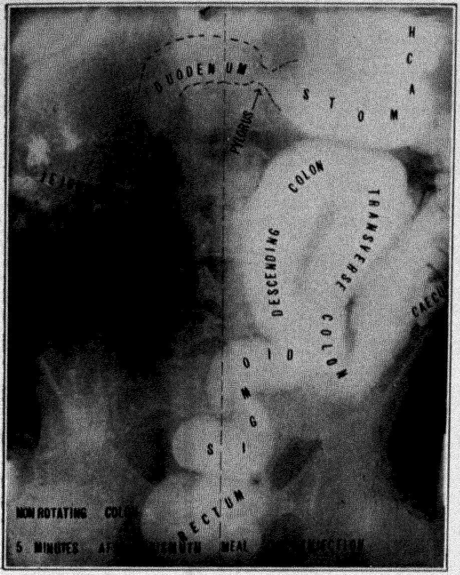
Rönt. XIX.—Congenital Pyloric Stenosis in Infancy. The radiographs show *some* of the meal going through the pylorus, so that operation was not performed. Compare with Rönt. XX.



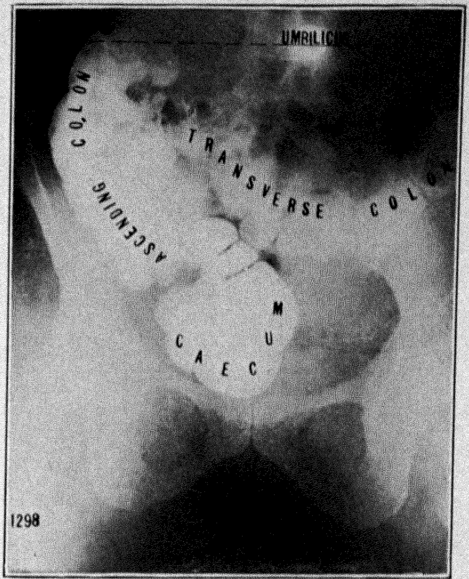
Rönt. XX.—Congenital Pyloric Stenosis in Infancy. The radiographs showed *none* of the meal passing through the pylorus. Operation imperative. (Operation by Dr. C. L. Gibson.)



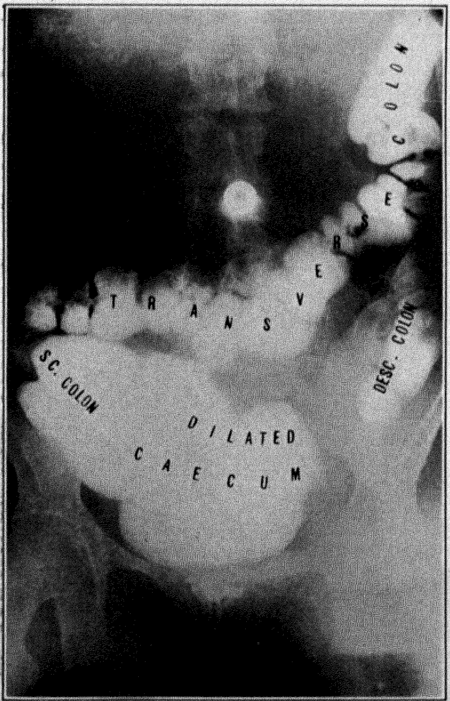
Rönt. XXI.—Congenital Pyloric Stenosis in an Infant 8 Weeks Old.



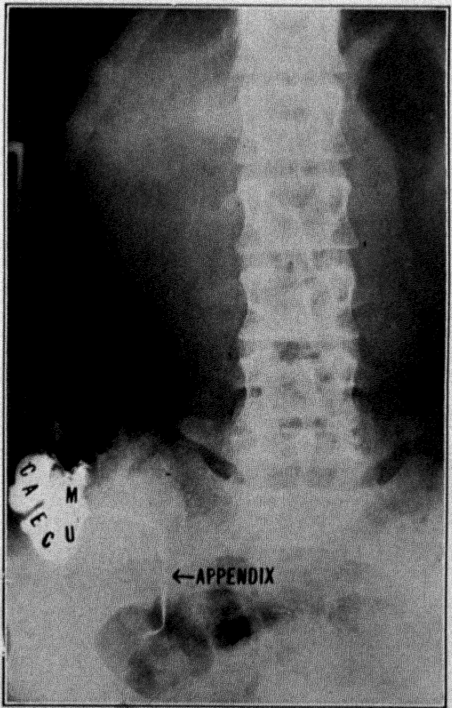
RÖNT. XXII.—NON-ROTATION OF THE COLON. The *entire* colon is to the *left* of the median line. The second and third portions of the *duodenum* pass freely to the *right* instead of behind the stomach.



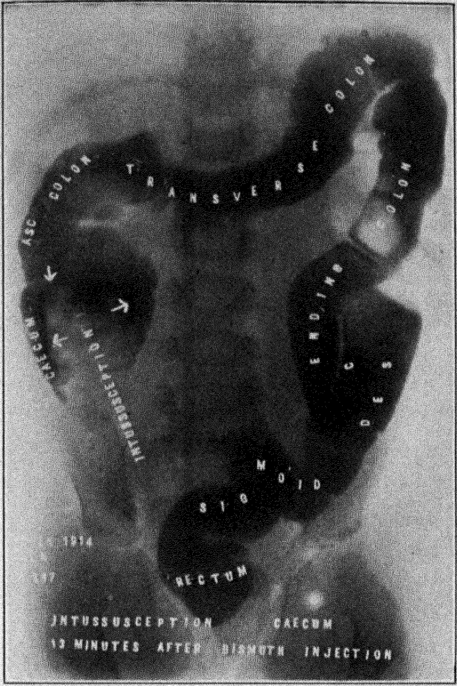
RÖNT. XXIII.—CECUM MOBILE. The cecum reaches to the symphysis and passes to the left of the median line.



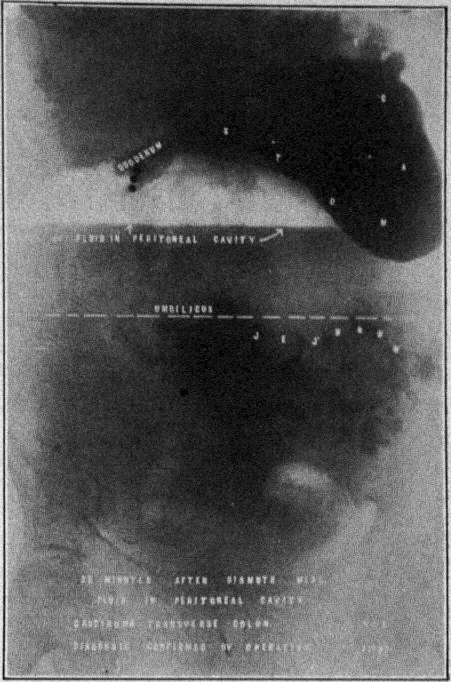
RÖNT. XXIV.—DILATED, MOBILE CECUM. The condition had been diagnosed as ovarian cyst by one who had examined her for pelvic trouble.



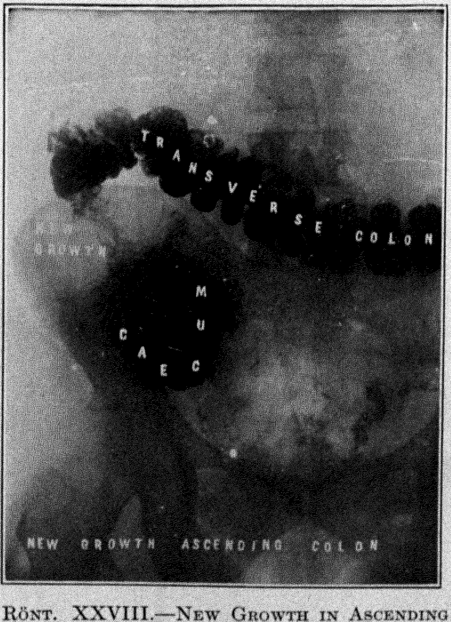
RÖNT. XXV.—CHRONIC APPENDICITIS. Cecum and appendix retained the test-meal after it had been eliminated from the rest of the tract.



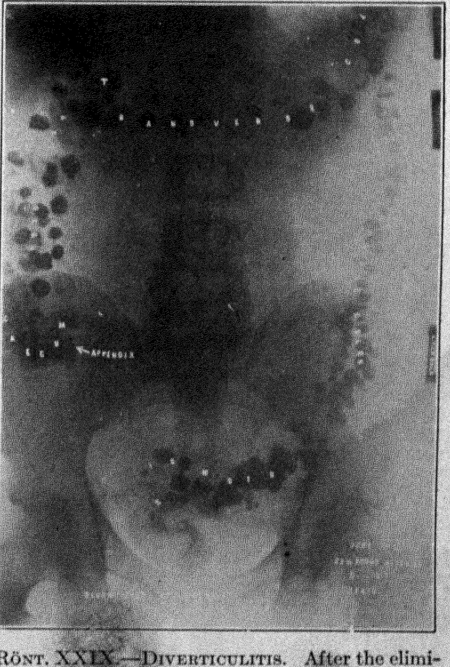
RÖNT. XXVI.—INTUSSUSCEPTION. In a child. No tumor felt so that until Röntgen examination showed it to be at the cecum, intussusception was *thought* to be on the *left* side. (Operation by Dr. Walton Martin.)


DUODENUM
STOMACH
FLUID IN PERITONEAL CAVITY
UMBILICUS
JEJUNUM
MINUTES AFTER BISMUTH MEAL
FLUID IN PERITONEAL CAVITY
CARCINOMA TRANSVERSE COLON
DIAGNOSIS CONFIRMED BY OPERATION

RÖNT. XXVII.—FLUID IN PERITONEAL CAVITY. Case of carcinoma of transverse colon. (Operation by Dr. W. A. Downes.)



RÖNT. XXVIII.—NEW GROWTH IN ASCENDING COLON. Demonstrated by the narrowed lumen. (From a radiograph by Dr. J. T. Case.)



RÖNT. XXIX.—DIVERTICULITIS. After the elimination of the bismuth injection, bismuth-filled pockets remained for days as far back as the cecum.

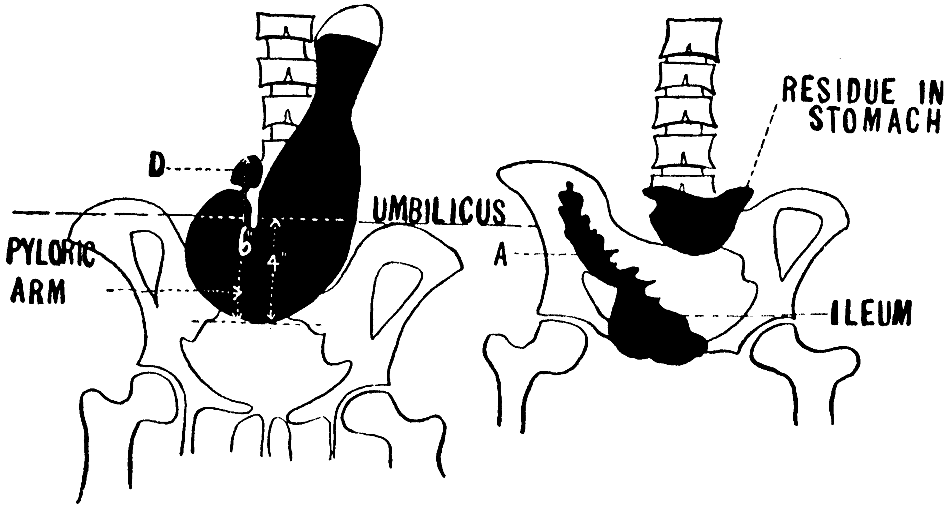


FIG. 9.—WATER-TRAP STOMACH. Greater curvature 4 inches below the umbilicus. Pyloric arm (distance from highest point of duodenum to the greater curvature) 6 inches. Note the *residue* in the stomach at the 6th hour. These two points are of extreme diagnostic importance. A, Ascending colon; D, duodenum. (Operation by Dr. W. A. Downes.)

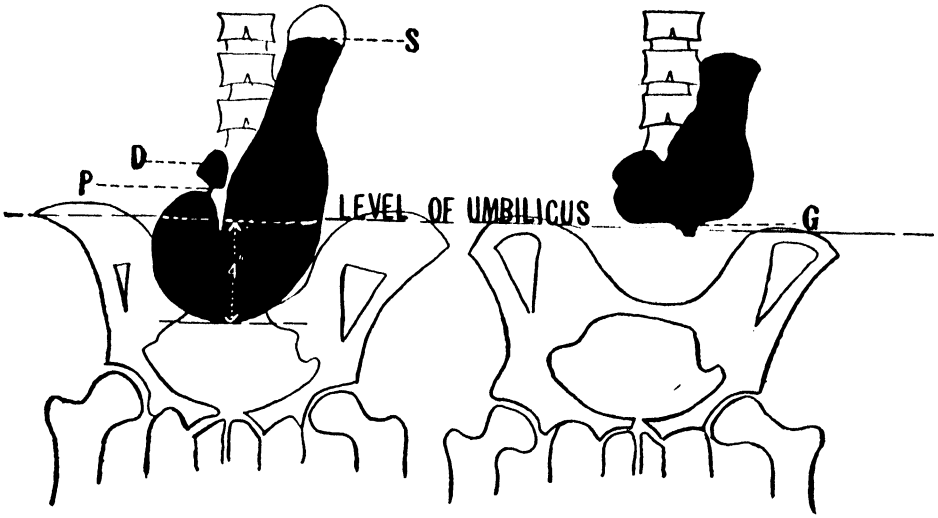


FIG. 10.—WATER-TRAP STOMACH. Cured by *gastro-enterostomy and closure of the pylorus.* Note who the stomach has regained its normal size and tonicity. The patient was relieved of all gastric distress which was due to residue, as shown in Figure 9. D, Duodenum; G, gastro-enterostomy opening; P, pylorus; S, gas at the cardiac end of the stomach. (Operation by Dr. W. A. Downes.)

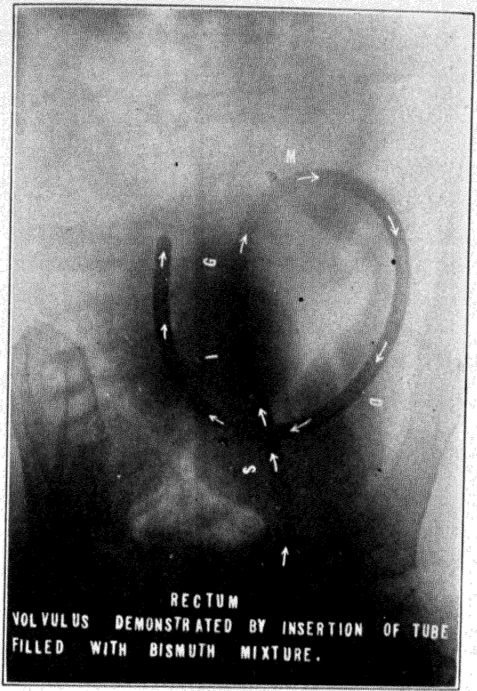
or corset for support. And just as surely as some hernias become incarcerated or even strangulated and would cause death if not relieved by a proper surgical procedure, so some water-trap stomachs become absolutely incapable of functioning properly and lead to such a state of malnutrition as to directly or indirectly tend to a fatal termination unless relieved by a proper surgical procedure. Furthermore, just as for years there were numerous varieties of operations for the cure of inguinal hernia and many recurrences following operation, so the selection of a proper technic for the cure of water-trap stomach is passing through a similar period, and will eventually be worked out as perfectly and surely as has the operation for the radical cure of inguinal hernia, and to the Röntgen ray the credit will be largely due.

Water-trap stomach (Fig. 9 and Rönt. XV) is a distinct morphological entity (116, 117, 138, 139), a deformed organ which gives rise to a certain definite train of symptoms.

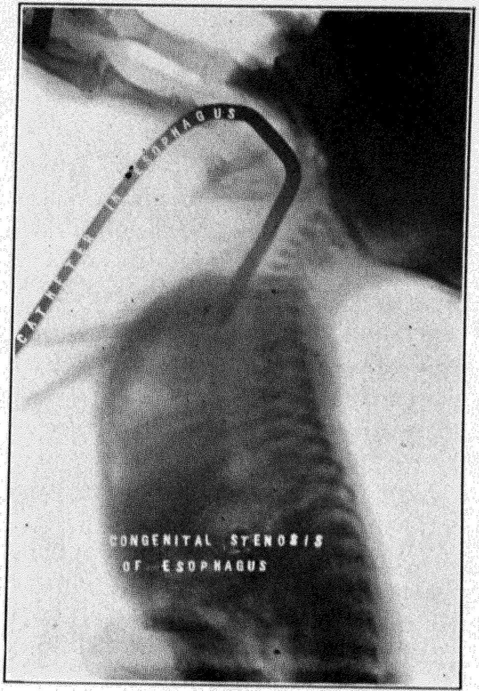
The chief characteristic of this stomach is the relatively high, but normally placed, pyloric outlet, which is well held up to the spine by the gastrohepatic ligament and the retroperitoneal tissue. The vertical diameter is always long. In 16 cases which I studied in detail, the longest diameter, usually nearly vertical, varied from 23 to 38 cm. (from 9 to 15 in.), averaging 26 cm. (10½ in.). The distance from the junction of the first and second portion of the duodenum to the most dependent portion of the greater curvature is abnormally long. This portion of the stomach, briefly referred to as the pyloric arm, varied from 13.5 cm. (5¼ in.) to 24 cm. (9½ in.). In other types of stomach this distance varied from 4 cm. (1½ in.) to 8 cm. (3 in.), which length is in itself sufficient to rule out deformity of water-trap type. The average length of the pyloric arm in the 16 cases referred to was 16.5 cm. (6½ in.). The distance below the umbilicus, or from a line drawn across the upper level of the iliac crests, varied from 7.5 to 20 cm. (from 3 to 8 in.). This distance in normal stomachs averages 3.5 cm. (1½ in.). These measurements were made on röntgenograms taken from 1 to 5 minutes after the administration of a bismuth meal consisting of 90 gm. of bismuth subcarbonate suspended in 600 c. c. of fermented milk. The water-trap stomach might almost be considered as a ptosed organ, with the first portion of the duodenum and the pylorus fixed in proper position, giving the characteristic long pyloric arm and resemblance to a water-trap.

The colon in 16 cases critically studied was ptosed in amount corresponding to the degree of ptosis of the greater curvature of the stomach. In practically every case of water-trap stomach the colon is either ptosed or there is a very long loop in the transverse portion, which corresponds in contour to the greater curvature of the stomach. In our classification of colons we consider the colon ptosed only when the cecum and hepatic flexure are ptosed, for it is the exception to find the colon high when the cecum is ptosed.

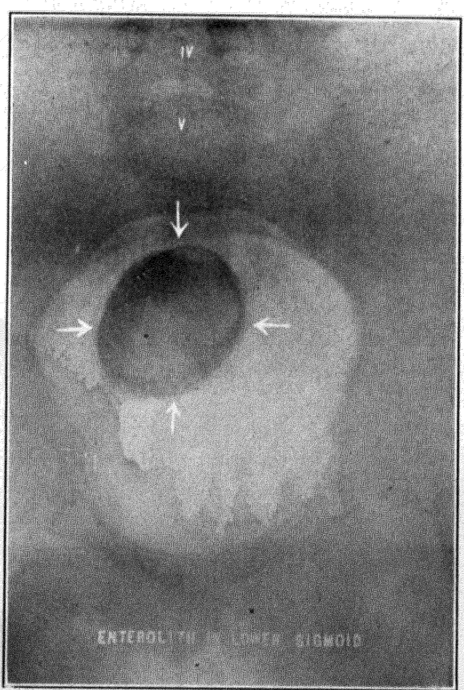
It will be noted that the water-trap deformity is extremely rare in men. It is also of paramount importance to note that child-bearing can have little or


M
G
I
O
S
RECTUM
VOLVULUS DEMONSTRATED BY INSERTION OF TUBE FILLED WITH BISMUTH MIXTURE.

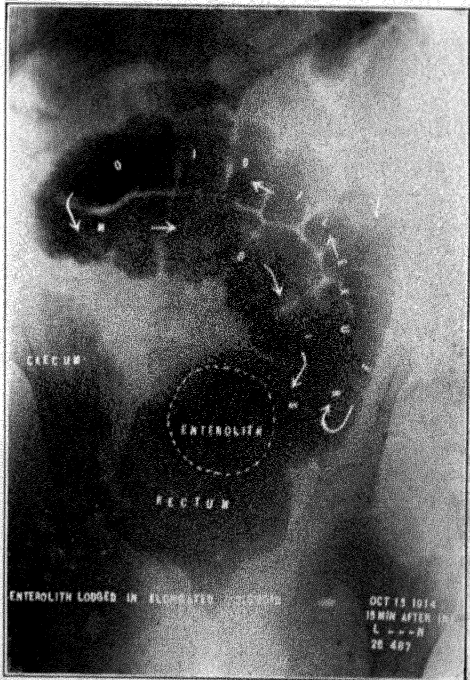
RÖNT. XXX.—VOLVULUS OF THE SIGMOID FLEXURE DEMONSTRATED BY INSERTION OF A TUBE FILLED WITH BISMUTH MIXTURE. The symptoms of obstruction relieved in this way. (Case of Dr. W. A. Downes.)



RÖNT. XXXI.—CONGENITAL STENOSIS OF THE ESOPHAGUS. Demonstrated by passing a catheter down to the point of obstruction. (From a radiograph by Dr. E. D. Truesdell, taken at the New York Lying-in Hospital.)



RÖNT. XXXII.—ENTEROLITH IN THE LOWER PORTION OF THE SIGMOID FLEXURE. Female, age 13 years. Condition diagnosed by coating of Bismuth which remained after the elimination of the Bismuth meal.



RÖNT. XXXIII.—ENTEROLITH IN THE LOWER PORTION OF THE SIGMOID FLEXURE. Same case as XXXII. Note the extreme elongation of the sigmoid so that it passes completely over to the right side.

no relation to the lesion, because half of our cases have occurred in unmarried women. Only 4 out of the 16 cases especially studied were multiparæ. While these patients have invariably suffered for years with symptoms erroneously diagnosed as neuralgia of the stomach, ulcer of the stomach, nervous indigestion, neurasthenia, or dyspepsia, the limit of endurance has been reached only after about 15 years of suffering. And while we have observed the water-trap deformity of the stomach in early youth and a tendency to the condition in childhood and even in infancy, as shown by röntgenograms, the usual time at which patients present themselves for radical treatment is between the ages of 30 and 40. It is conceivable that this condition of the stomach is aggravated by faulty living, improper food, and constipation, but it is more probable that the true water-trap stomach has a close analogy, for example, to inguinal hernia, which is now universally conceded to be congenital in origin with trauma superimposed. If this be true, it is at once evident that the water-trap deformity, when of marked degree, is as surely amenable to surgery as is the irreducible hernia. (Fig. 10 and Rönts. XVI and XXVIII.) Vomiting is shown by Table 1 as infrequent, and is rarely a marked symptom. Residue in the stomach is much more frequent, and part of the symptoms can often be traced to this condition. Coloptosis is nearly always present, although about 16 per cent. show no ptosis, and 4 per cent. show an abnormally long colon without any ptosis. Constipation is, apparently, not so strong a factor as is generally supposed.

TABLE 1.—ANALYSIS OF ONE HUNDRED CASES OF WATER-TRAP STOMACH

	No. of Cases
Males	4
Females—	
Married	47
Single	49
Between ages of 15 and 19	4
Between ages of 20 and 29	28
Between ages of 30 and 39	37
Between ages of 40 and 49	20
Between ages of 50 and 59	10
Over 60 years	1
History of vomiting obtained in only 35 cases—	
Residue shown in	55
Colon ptosed shown in	84
Constipation shown in	45
Operated on	18

We know that constipation is improved and, in some cases, relieved by suspension of the stomach and colon. (Rönt. XVIII.) There is ground to believe that this may in part be due to the increased amount of water turned into the colon, or to reëstablishment of the normal activating processes of the peristaltic enzymes. Water has been shown, experimentally, by Draper, to be absorbed vicariously from the stomach under condition of intestinal obstruction. When these stomachs are successfully operated on, they empty completely within a few hours, so that the water which previously was absorbed from the stomach now has a chance to reach the colon and thereby prevent constipation. (Fig. 11.)

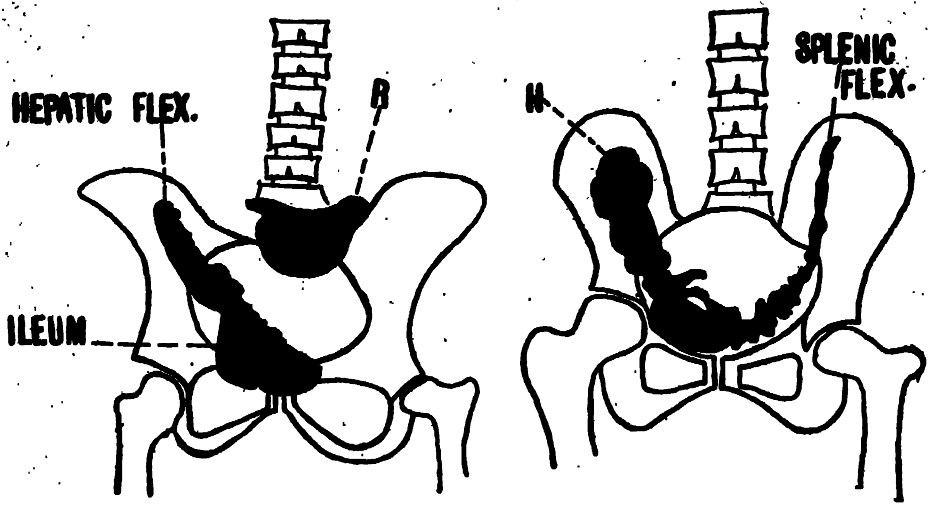


FIG. 11.—CONSTIPATION RELIEVED BY GASTRO-ENTEROSTOMY. Before operation the test-meal had advanced only to the *hepatic flexure*. After operation the test-meal traveled to the *splenic flexure in the same time*. R, Residue in stomach; H, hepatic flexure. (See Fig. 10 for appearance of stomach.) The second illustration shows the absence of residue in the stomach at the 6th hour as compared to the first illustration showing amount of residue in stomach before operation. The rapid emptying of fluids after gastro-enterostomy relieves the constipation. (Operation by Dr. W. A. Downes.)

Furthermore, in considering the shape and position of the viscera, and in studying the symptomatology, there appears to be a very constant drag of the ptosed, hollow viscera on the visceral nerves and blood vessels, and this drag must be an important symptomatic factor. **Another factor is the presence of a residue in the stomach long after the usual emptying time. Such a residue was demonstrated in the röntgenograms in 50 per cent. of the cases.** The muscular action and the resultant emptying coefficient in practically all of these patients are below par. This condition, I believe, is due largely to congenital causes, such as faulty development of the gastro-intestinal tract associated with abnormally long mesenteries of the stomach or colon and the very common condition of elongated sigmoid flexure.

Pyloric Obstruction in Infants (37, 131, 132, 134).—A review of the literature makes it very evident that pyloric obstruction is spoken of under many varying titles in a very loose manner. This indefiniteness has arisen from the fact that there has not as yet been established a sharp line of demarcation among the various types of pyloric obstruction in infants.

Various ingenious theories have been advanced which are supposed to account for its causation. One set of writers doubts that the condition is congenital at all, since its manifestations rarely appear before the third week.

Others attempt to prove that it has its origin in fetal life and quote the case of Dent, who found a so-called pyloric tumor at autopsy in a 7 months' fetus. Ibrihim and his followers take the ground that the cases are varying degrees of pyloric spasm, while another group of writers differentiates between cases having a true tumor and those of simple spasm.

An analysis of the rather voluminous writings on this topic, with its many theories, forces one to the conclusion that, after all, little has been gained by these controversial theories, and that they do not tend to assist very materially in an elaboration of the diagnosis, nor to establish a definite form of treatment which, after all, is the important practical end which we seek.

Certain cases which exhibit the classical group of symptoms, namely, projectile vomiting, steady wasting, constipation, excessive stomach peristalsis, in addition to a palpable nodular tumor in the pyloric region, we must regard as true cases of pyloric stenosis. Enough cases have been reported with pathologic findings which so uniformly bear evidences of a marked hypertrophy of the circular fibers of the pylorus, and a corresponding diminution in the lumen of the viscus at this point, that it would seem irrational to deny the existence of this type, which may be termed surgical. On the other hand, cases are reported without the presence of any palpable tumor, but otherwise having all the usual symptoms in varying degrees of severity. It is perhaps in these that the greatest difficulty arises to determine the best method of procedure and in how far they may be surgical. The suggestion is given by the majority of writers that cases in this group should be treated medically until the time when they resist medical management, as evidenced by a stationary or falling weight. They may then be subjected to laparotomy with its high degree of hazard, the operator being necessarily uncertain as to his method of procedure until he has satisfactorily explored the stomach. If a tumor is found at the operation, which from its position has heretofore been undiscovered, the infant must be able to withstand a considerable degree of shock incident to the performance of a posterior gastrojejunostomy. If no tumor is found, little has been gained and possibly much lost by subjecting the impoverished infant to a loss of blood and further depletion of its natural resistance. Hutchinson, in his Schorstein lectures, is of the opinion that all cases should be treated medically first. He can find no satisfactory means of differentiating the surgical from the medical without preliminary treatment.

If, therefore, we may, by the use of the modern methods, so complete our diagnostic means that we can, with a degree of positiveness, determine whether or not a given case shall be operated upon or treated without the use of a knife, we shall be making an advance worth while.

Notable achievements have lately been made in röntgenology, especially with the use of bismuth in the alimentary tract. The workers have, however, for the most part, confined their studies to conditions as they appear in adults. The apparatus at their command heretofore demanded exposures of varying lengths of time, and in the young, unruly subject it often necessitated the use of a general anesthetic to enable the operator to make an exposure with any degree of satisfaction. Modern apparatus, with the intensifying screens, enables the radiologist to make instantaneous exposures, thus securing, with the minimum effort, negatives of value.

Whether the stomach is at this time of life a natural reservoir, at the same time performing its share of the preparation of foods for the higher and more complex processes of digestion in the duodenum, or whether it is simply a dilated pouch intended for the accumulation of a quantity of food, which is quickly acted upon by the gastric juice and immediately allowed to pass out through the pylorus, is a question for future and more elaborate study. The fact that we may observe the exit of food into the duodenum within a minute or two after its intake rather tends to show that we may have been overvaluing this portion of the alimentary tract.

That liquid foods begin normally to be expelled in a very short time after they are taken into the stomach is very helpful in our diagnosis of conditions dealing with some form of pyloric obstruction, for, if we can demonstrate, with a degree of exactness, by a series of radiographs, that the milk is retained for a greater length of time than in a normal stomach, as shown by the bismuth shadow, we can determine with a fair degree of certainty with what type of obstruction we are dealing. If such striking results can be obtained by this means, it would seem to us manifestly unfair not to obtain early a series of röntgenograms in every suspected case, so that the infant suffering from a true tumor with a lumen so small as to practically occlude the passage of food into the duodenum may be early given over into the hands of the surgeon, while its physical condition is still good. On the other hand, cases of pyloric spasm, even of marked degree, but without tumor formation, can be differentiated, since the time and the amount of the food passing through the pylorus can be seen and thus the diagnosis, and even the prognosis, can be fairly well fixed.

The findings have been so illuminating that the prophecy may be made that in the future every suspected case of pyloric obstruction will be subjected to a radiographic study before a plan of treatment is determined upon, just as to-day no surgeon would think of putting up a fracture without the use of the rays. (See Rönts. IX, XX and XXI.)

THE DUODENUM

Lesions of the first portion of the duodenum bear considerable relationship röntgenologically to lesions at the pyloric end of the stomach, and they are usually studied simultaneously with the examination of the stomach.

Congenital Anomalies.—The duodenum in cases of non-rotation of the colon also shows a marked variation from the normal. It passes out to the right in almost a straight line with the axis of the pylorus, which in these cases is not curved upward, but is on a level with the lower pole of the stomach, making the stomach rather a reversed L-shape, instead of the more usual J-shape. A lack of familiarity with this anomaly has to my knowledge caused a wrong interpretation to be placed on Röntgen-ray findings in two instances by röntgenologists, leading in one case to the diagnosis of a lesion of the duodenum requiring early operation, which, fortunately, however, was not performed, as the patient declined to have the operation. In the other case a diagnosis of ulcer at the pylorus, with dilatation of the duodenum, was made and operation advised. Laparotomy was performed and the true condition—namely, non-rotation of the colon—was revealed. The abdomen was closed without further procedure.

This condition can always be recognized if the Röntgen examination of the digestive tract is complete, that is, if the examination is not confined to the stomach, but includes the colon. (Rönt. XXII.)

Another anomaly which may be encountered is transposition of the duodenum to the left side, in cases in which the stomach is on the right side of the abdomen, and the other viscera likewise transposed. In the 8 cases of this condition which I have encountered the transposition of the abdominal and thoracic viscera has been complete. (See Rönt. III.)

In the second and third portions of the duodenum, in addition to the anatomical peculiarities noted in the first portion, there may be variations in the shape, length, and direction. The second portion may turn to the left and pass behind the stomach. In other cases it may pass far to the right and encircle the pyloric end of the stomach.

Duodenal Ulcer.—Superficial acute ulceration of the duodenum may give no definite evidence röntgenologically. Even at laparotomy these superficial lesions of the mucous membrane may not be felt, and may be overlooked unless the duodenum is incised and inspected. Cases of fatal hemorrhage have been reported soon after laparotomy which failed to reveal duodenal ulcer diagnosed clinically or radiographically.

Chronic ulceration of the duodenum may be diagnosed with extreme accuracy by several methods of carefully followed technic, as follows:

According to Carman's experience at the Mayo Clinic:

"The röntgenologic indications of duodenal ulcer, which have been frequently catalogued by various observers during the past two years may be divided into major and minor signs.

"The major signs are:

"1. Gastric hyperperistalsis.

"2. A residue in the stomach (sometimes in the duodenum) after six hours, if there be obstruction from scar contraction.

"3. A diverticulum of perforation ulcer.

"The minor signs include:

"1. Gastric hypermotility with early free opening of the pylorus and speedy clearing of the stomach.

"2. Gastric hypertonus.

"3. Irregularities in the outline of the cap or bulb, or of the duodenum.

"4. Lagging of bismuth in the duodenum.

"5. Pressure-tender point over the duodenum.
"6. Spasm of the stomach such as hour-glass or slowly traveling incisura.

"Of all the radiologic signs of lesions of the digestive tract the presence after six hours of a distinct residue from the barium or bismuth meal is perhaps the most important. The radiologist feels assured that almost without exception such a residue signifies an organic lesion, whether or not all his diagnostic deductions be confirmed. Theoretically, a residue may remain in simple atony, but of our cases with residue which came to operation every one was found to have some condition requiring surgical intervention.

"A residue in the stomach from the barium or bismuth meal, six hours after its ingestion, occurs in a large proportion of cases of duodenal ulcer. This is often loosely spoken of as being due to pyloric obstruction, whereas the obstruction is actually in the duodenum and is produced by ulcer—scar contraction. Occasionally there will be found not only a six-hour residue in the stomach, but also a six-hour residue in the duodenum above the stenosis, thus enhancing its diagnostic value. A six-hour residue may, however, also be found in the stomach as a result of gastric ulcer or carcinoma, or thickening of the pyloric ring. A six-hour residue in the duodenum may result from bands of adhesions, or from the pylorospasm incident to gall-bladder disease.

"Hyperperistalsis in conjunction with a six-hour residue is worth more than 95 per cent. in diagnosis.

"The exaggerated peristalsis of duodenal ulcer does not appear to be related to the degree of hyperacidity. The average total acidity in eighty cases with hyperperistalsis was 69.7 per cent., while in seventy-two cases without hyperistalsis the average total acidity was 74.8 per cent. The highest acidity noted, 120 per cent., occurred in a case with normal peristalsis.

"Though the Röntgen ray often fails in the positive diagnosis of duodenal ulcer, its findings have an exclusion value. That is to say, the chance of some other lesion existing is minimized in proportion as the latter is radiologically determinable.

"Hypermotility, hypertonus, deformity of the cap or bulb, lagging of bismuth in the bulb, pressure-tender point over the duodenum and spasm of stomach are minor contributory radiologic signs of duodenal ulcer. The combination of hyperistalsis and six-hour residue or a diverticulum, when found in an otherwise normal stomach, constitute about the only evidence on which a purely radiologic diagnosis of duodenal ulcer may safely be advanced."

According to Case:

"Defects in the duodenal bulb constitute one of the chief röntgenographic means of recognition of duodenal ulcer and its complications. Filling defects in the duodenal shadow, to be interpreted as ulcer should be differentiated from the normal defects due to hepaticoduodenal ligament and the deformities of the bulb due to extraduodenal pressure, as, for instance, gall-bladder, blood-vessels, second portion of the duodenum, etc. The defects due to gall-bladder region adhesions are very characteristic; the defect occurs on the gall-bladder side of the bulb shadow, but the bulb is otherwise anatomically normal."

According to Cole:

"The induration surrounding an ulcer projects into the lumen of the cap, causing a displacement of bismuth, as constant as one's finger-prints in a ball of putty. It may be so small that its projection presents only a constant dent in one side of the cap or it may be so extensive as to distort the lumen of the cap beyond recognition. The induration may involve one-half of the cap without distorting the other half. In such a case, the entrance of the lumen of the pyloric sphincter is an important guide in determining the center of the cap. The puckering from the cicatricial contraction may cause a deformity equally as great as the induration. Indeed, it is doubtful if one can determine radiographically whether the deformity is due to induration or adhesions, or which predominates. If one radiograph out of fifty shows a perfectly symmetrical cap and a normal pyloric sphincter, as previously described, one is justified in making a negative diagnosis of post-pyloric ulcer. If the cap is contracted and worm-eaten, but not drawn to the right, and the duodenal surface of the sphincter is irregular, duodenal ulcer should be considered."

According to George:

"We believe that by means of the Röntgen bismuth examination of chronic gastro-intestinal diseases we can often obtain positive diagnostic evidence which is unobtainable by any other means.

"Ninety-five per cent. of all duodenal ulcers appear on the superior surface of the duodenum with the cicatrix extending either posteriorly or anteriorly or both, but rarely on the inferior surface.

"Every duodenal ulcer which is more than a simple peptic erosion has a sufficiently deep cicatrix to deform the bismuth contour.

"What we mean by this is the presence constantly, on a series of plates, of a definite abnormality in the contour or structure of the bismuth mass. In connection with this we wish to mention here that probably the greatest value in the Röntgen diagnosis of the gastro-intestinal diseases lies in the possibility of classifying cases into medical or surgical categories. It is only in the cases which may be classed as surgical that we feel we are able to obtain really positive Röntgen evidence."

Deformity of the duodenum due to adhesions or pressure may be recognized by Röntgen examination, the most common cause being biliary calculi. (Rönt. XIV.)

Dilatation of the Duodenum.—Duodenal dilatation may be diagnosed with certainty, and the cause may be determined in certain cases in which adhesions are present, a kink is present at the duodenojejunal angle, or pressure is present from a tumor of the pancreas or neighborhood.

Tumor of the duodenum itself may occasionally be encountered. Deformity, obstruction, and gastric residue may be present in such cases.

THE JEJUNUM

Few lesions are encountered in the jejunum. Foreign bodies may rarely lodge here. Obstructions from new growth or surrounding adhesions may be diagnosed. Spontaneous anastomosis with the stomach has been encountered by me in a case of tuberculosis.

THE ILEUM

Obstructive lesions are more commonly encountered here. Simple kinks (Lane's kink) due to angulation with adhesions near the ileocecal junction may be diagnosed. Cases complicated by chronic appendicitis are not infrequent. Tumor, or chronic inflammatory lesions, such as tuberculosis, may cause almost complete obstruction in the region of the ileocolic junction. Enteroliths may be found here. They may receive a coating of bismuth and thus show after the main bismuth meal has passed by.

THE ILEOCECAL VALVE

Spasm.—Spasm may occur and give temporary obstructive findings, or delayed emptying time. Extreme care must be used in the interpretation of the Röntgen findings in cases of apparent stasis in the ileum. The most common source of error is that the fact of delayed emptying time of the stomach is not taken into consideration. So that for accuracy one must know the time at which the last of the test meal has left the stomach, and estimate the emptying of the small intestine from that time until the entire meal has entered the cecum.

Incompetency.—This may be occasionally diagnosed by means of the test meal. It may be observed that a portion of the meal actually passes back into the ileum after all the meal has entered the colon. Some care in interpretation is necessary here, as occasionally loops of sigmoid may be superimposed on the cecum and simulate coils of ileum.

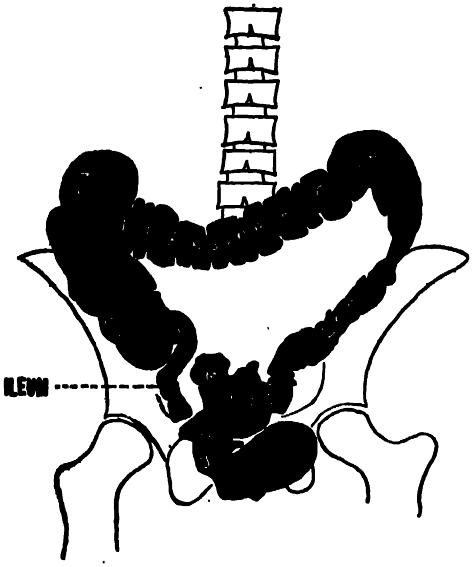


Fig. 12.—Incompetent Ileo-cecal Valve. Condition demonstrated by the passage of bismuth injection through the valve.

Positive diagnosis can be made by means of a properly administered opaque injection given after a careful cleansing enema (Fig. 12). Repeated examination may be necessary. Examination after the elimination of part of the opaque enema may give a positive finding.

Rarely the injection may pass through the valve in large amount and fill the whole small intestine.

THE APPENDIX

The location of the appendix is of great importance. In cases of non-rotation of the colon and of transposition of the viscera this is particularly true. Even if the appendix itself cannot be made to take the opaque mixture, the location of the cecum can always be ascertained in these cases, and the location of the appendix inferred. (Rönt. XXII.)

The presence of certain *foreign bodies*, such as a pin or tack or concretion, may be ascertained.

The exact *size, shape, length, and emptying time* may be ascertained in a surprisingly large number of cases. The exact *position* and the presence of *adhesions* may be diagnosed. (Rönt. XXV.)

THE CECUM

Congenital Anomalies.—Non-rotation of the colon has been observed by a number of röntgenologists, and has been discovered at surgical operations. In this condition the cecum is usually found well over on the left side and may be high up. In obscure cases of acute or chronic intra-abdominal trouble it is exceedingly important to determine the position of the cecum and directly (or by inference) the location of the appendix. Thereby much delay in the operative procedure may be avoided, and a left-sided appendicitis accurately diagnosed and treated. (See Rönt. XXII.)

In complete transposition of the viscera (and in my experience all cases are complete) the cecum and appendix will be found on the left side. An exception to this might be a case of non-rotation of the colon in a case of transposition of the viscera, in which case the double anomaly would bring the cecum and appendix back on the right side of the abdomen. No such case has been reported, but the possibility of its occurrence cannot be denied.

Ptosis.—This condition in variable degrees is a very common occurrence. In fact, Röntgen-ray examination in the vertical position reveals the cecum in the average normal individual from 1 to 2 in. (2.5 to 5. cm.) lower than that given in the anatomies whose descriptions have been based on dissection in the horizontal position. This means that the base of the appendix is nearer the brim of the pelvis in the standing position, and not higher up on the line between the anterior-superior spine and the navel, as formerly described. (See Rönt. XXV.)

Cecum Mobile.—This condition is frequently wrongly diagnosed as ovarian tumor, floating kidney, etc., until a carefully made Röntgen-ray examination reveals the true condition. While a very movable ptosed cecum may be encountered in the course of a Röntgen-ray examination and not be giving symptoms, yet it is an unfortunate condition and may later become distinctly pathological, just as a relaxed inguinal ring or a bubonocele may develop into a true hernia. (See Rönts. XXIII and XXIV.)

The most reliable test is its emptying time. A ptosed cecum which retains portions of the test opaque meal more than 2 days after its ingestion is a pathological one, unless there is present a distinct point of more or less obstruction at some part of the large intestine distal to the cecum, such as an extreme ptosis of the transverse colon, sharp angulation at the splenic flexure, elongation of the sigmoid, the presence of a new growth or constricting bands of adhesions or a Jackson's membrane.

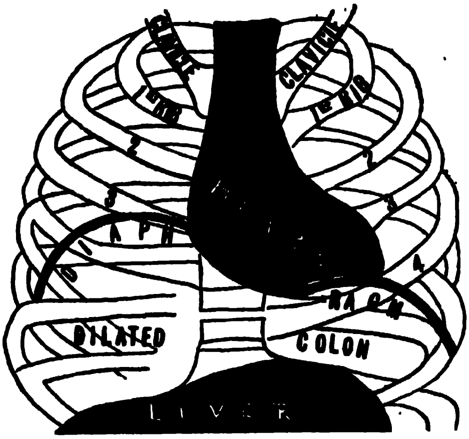


FIG. 13.—BILATERAL EVENTRATION OF THE DIAPHRAGM. This very rare condition was observed in a male, aged 44, who suffered from repeated attacks of partial intestinal obstruction. The colon was found to be enormously dilated and pressed against the diaphragm on both sides, displacing the normal liver shadow.

The ptosed cecum may become extremely dilated, reaching the size of a large grape fruit. Such a cecum may retain portions of the opaque meal for a week after its ingestion.

Jackson's membrane, or adhesions from appendicitis, may at times be suggested by Röntgen examination.

New Growths.—A tumor in this region may cause a lack of proper filling out of the cecum, or may cause more or less obstruction and thus lead to a definite diagnosis. A confirmatory examination by means of an opaque injection is a necessary part of the Röntgen examination.

Foreign Bodies.—Owing to reverse peristalsis a foreign body may be carried back from any part of the large intestine to the cecum, or a foreign body having reached the cecum from the ileum may lodge in the cecum.

THE COLON

Simple atonic dilatation is frequently encountered. It may be of severe enough grade to make excision, or partial excision, advisable.

Megacolon.—True Hirschsprung's disease may be definitely diagnosed by Röntgen examination.

Dilatation of a portion of the colon may be met with and point the way for proper surgical procedure. I have met with 2 cases of peculiar dilatation of the colon so that loops of the colon were in apposition with the diaphragm on not only the left side, but also on the right side, displacing the liver and spleen downward. (Fig. 13 and Rönt. XXX.)

Adhesions.—These may occur at any part of the large intestine and cause more or less obstruction or deformity of the colon. By palpation under the fluoroscope, or röntgenographing in various postures, one may determine whether certain areas are fixed or adherent.

New Growths.—These may occur in any portion of the large intestine. The presence of a new growth may be manifested by more or less obstruction to the progress of the opaque meal. A control examination should be made by an opaque injection observed fluoroscopically, and confirmed by stereoscopic röntgenography. (See Rönt. XXVIII.)

The technic of Case should be closely followed.

"Röntgen findings in carcinoma of the bowels may be stated as follows:

"1. Delay in the onward progress of the bismuth column following a meal of bismuth-mixed food.

"2. The introduction of a bismuth clysma into the colon shows an arrest.

"3. A dilatation of the colon on the proximal side of the lesion.

"4. There may be a palpable tumor coinciding with the filling defect.

"*Technic.*—The examination should be conducted both following the injection of a bismuth clysma and following the ingestion of a bismuth meal. Where the symptoms point to bowel obstruction, it is probably more expeditious to employ the bismuth clysma first.

"As the opaque medium for intestinal work, the writer now employs barium sulphate. For the barium clysma, the ordinary barium sulphate is satisfactory, but for the bismuth meal we have always insisted on using the specially tested barium sulphate prepared by Merck, Squibb, or other reliable houses. The writer has used barium sulphate for nearly two years for the clysma and for over a year as the opaque medium for the test meal. The clysma employed consists of 90 grm. barium sulphate in $1\frac{1}{2}$ litres of warm water. (To $2\frac{1}{2}$ dr. of gum tragacanth add about 1 oz. of alcohol. Shake well. Add 20 oz. water, shaking well each time. This mixture should be made up freshly shortly before using.) When in haste, 90 gm. of barium sulphate may be stirred into $1\frac{1}{2}$ litres of one of the oriental clotted milks obtainable in this country under various names. The oriental clotted milks constitute a better vehicle than the ordinary buttermilk, retaining the barium sulphate in suspension for a much longer time.

"The clysma suffices for studying the mobility and relation of the colon and for determining the competency or incompetency of the ileocecal valve. When the study of the motility is desired, the test meal is preferable.

"The patient having been prepared, he is asked to lie supine upon the trochoscope, and a rectal point attached to an ordinary enema tube and container is inserted into the rectum. The barium suspension in the container should be placed two feet above the patient and should be allowed to flow by gravity, assisted at the proper moment by manipulating an ordinary bulb syringe. The rectal point should be introduced only past the sphincter—not more than two or three inches. It is not only unnecessary but it is almost impossible to introduce the tube higher into the bowel.

"The writer has discarded the use of the colon tube for all purposes. It is impossible, except in the rare cases of megacolon, to introduce a colon tube of any variety without coiling it upon itself in the rectal ampulla.

"The colon tube is furthermore quite unnecessary. The writer has given some thousands of bismuth injections with the patient lying supine upon the trochoscope, the rectal point introduced only past the sphincter; and only in cases of actual bowel obstruction has it been impossible to fill the cecum in three or four minutes by the pressure of gravity with the container at a height of two feet. The temperature of the clysma should be about 100° F.

"The progress of the clysma should be watched inch by inch as it ascends the colon. Should there be a pause in the onward progress, make sure there is not a kink in the rubber tubing or a clogging in the tube. At opportune moments during the inflow of the clysma, manipulation under the screen with the protected hand or with a wooden spoon may elucidate special points. Röntgenogram or tracing may be made at opportune moments to record special phases of the examination.

"Should the question arise as to whether or not a hindrance is spastic or organic, the administration of 1 mgm. atropine sulphate hypodermically may serve to rule out the spastic obstruction.

"In order to check up the findings in connection with the clysma examination, a bismuth meal examination will frequently be desirable. As a vehicle for a bismuth or barium sulphate meal, one may employ a farina mush or one of the oriental clotted milks, or the patient may be allowed to take the opaque salt in connection with an ordinary meal. When the stomach is being studied, the writer recommends the use of the oriental clotted milks or the farina mush, but when the object is to study the lower bowel, the nature of the vehicle is not important.

"At the twelfth, the twenty-eighth and possibly also the fifty-second and seventy-sixth hour, the colon should be studied with special reference to the hindrance above the point already under suspicion. A fluoroscopic screen examination is essential for the study of peristalsis, and especially for the detection of antiperistalsis."

Ptosis.—This may be confined t othe transverse portion, or to the hepatic or splenic flexure, or may include all of these structures, and occasionally the cecum in addition.

The transverse colon may be U-shaped, W-shaped, V-shaped, or S-shaped. It may fall so low that it hangs in the true pelvis.

Diverticulitis.—Diverticula may be found in any portion of the large intestine, but more frequently in the sigmoid, or the sigmoid and descending colon combined. (Rönt. XXIX.)

Their presence may be determined röntgenographically either by an opaque meal or by an opaque injection. The diagnosis is established by finding evidence of portions of the opaque substance remaining in the form of small rounded shadows after the main opaque mass has been evacuated. A diverticulum may retain some of the opaque substance for a period of a week or more after the main mass has passed. In this respect a diverticulum acts very much like a sluggish appendix in the way in which it may continue to retain the opaque substance, and it offers a similar indication for surgical intervention.

THE SIGMOID (ILIAC AND PELVIC COLON)

Variations in the length of this portion of the large intestine are very frequently encountered. An extra loop reaching to or far above the level of the umbilicus has been observed many times. Here again the question of ability to properly carry on its function is the crucial test as to the necessity for surgical intervention. (See Fig. 14 and Rönt. XXX.)

More than one extra loop may be present. A loop may pass to the extreme right side of the abdomen so that its shadow overlaps the shadow of the cecum. Enteroliths or fecoliths may be found in one of these dilated sigmoid loops. (Rönt. XXXII and XXXIII.)

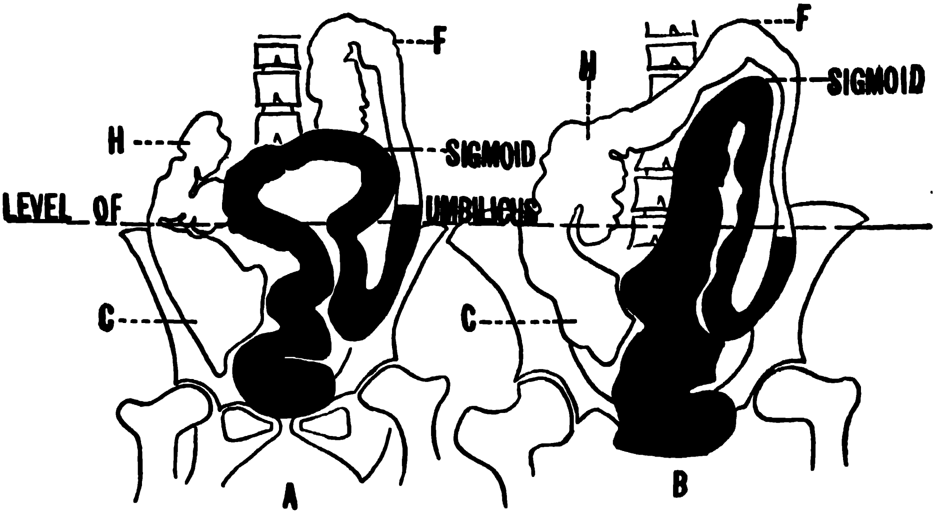


FIG. 14.—ENORMOUSLY ELONGATED SIGMOID FLEXURES. Case A suffers from constipation with periodic attacks of gastric disturbances. Case B is a young girl who is apparently in fair health but who was sent for Röntgen examination because "her bowels do not move for a week" unless she takes a cathartic. C, Cecum; F, splenic flexure; H, hepatic flexure.

THE RECTUM

The röntgenologist is not infrequently called upon to make an examination for lesions in the rectum. This may be done, but should be supplemented by direct inspection through the special instruments devised for this purpose.

THE PERITONEUM

Tuberculous peritonitis may be suggested by certain appearances found in the course of a Röntgen-ray examination of the gastro-intestinal tract. The findings consist mainly of evidences of adhesions about the small intestine, as well as the large intestine.

Ascites may at times be accurately diagnosed, and the exact level of the fluid ascertained. (Rönt. XXVII.)

Hernia through the diaphragm may be definitely diagnosed, and the contents of the hernia determined. The contents of *other varieties of hernia* may at times be determined with extreme accuracy.

Subphrenic abscess may at times be diagnosed.

THE GALL-BLADDER AND BILE PASSAGES

The presence of biliary calculi in the gall-bladder or bile passages may be definitely diagnosed with extreme accuracy when the calculi are of sufficient density throughout or have a coating of sufficient density to offer a contrast with the surrounding structures. (Rönt. XIII.)

The presence of biliary calculi or cholecystitis may be inferred in certain cases from the evidences of pressure from a distended gall-bladder, or distortion of the duodenum from the presence of adhesions. Occasionally pressure on the duodenum will be sufficient to cause delay in the emptying time of the stomach. (See Rönt. XIV.)

THE LIVER

The exact size of the liver can in many instances be determined. The upper border, as it follows the line of the diaphragm, is easily discerned. To outline the lower border, it may be necessary to fill the colon with gas or an opaque substance—bismuth, by mouth or by injection.

THE SPLEEN

In many instances the complete outline of the spleen may be observed. In other cases it may be inferred by the position of the adjacent colon and stomach.

THE PANCREAS

Enlargement of the pancreas, especially when due to cyst formation, can be noted usually by the displacement of the stomach and duodenum.

MISCELLANEOUS USES

The Röntgen ray is a most valuable aid in determining many other conditions which may arise in individual cases. It can be used to determine the location of fecal and other fistulæ, the direction of stab and bullet wounds, and for the determination of foreign bodies of metallic nature or considerable density in the abdomen, such as a heavy rubber drainage tube or a surgical instrument. It has been suggested that a metallic clamp of small size be fastened to all abdominal pads used during laparotomies so that, in case of one having been overlooked, it may be readily detected by the Röntgen ray.

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OPERATIONS UPON THE LIVER AND THE BILE PASSAGES

CHAPTER IV

OPERATIONS UPON THE LIVER AND THE BILE PASSAGES

ALEXANDER BRYAN JOHNSON

OPERATIONS UPON THE LIVER

Indications.—Operations upon the liver may be required for injury or for disease, as follows:

A. Operations for injury.
    1. For crushing injuries causing rupture of the liver, usually subcutaneous.
    2. For open wounds, stab or gunshot wounds.
B. Operations for disease.
    1. Abscess of the liver.
        a. Pyogenic.
        b. Amebic.

Conditions simulating liver abscess may rarely be caused by tuberculosis, actinomycosis, or a broken-down gumma.

    2. Echinococcus cyst of the liver.
        a. Evacuation.
        b. Extirpation of the sac.
    3. Cirrhosis of the liver.
    4. Tumors of the liver.

A. OPERATIONS FOR INJURIES OF THE LIVER

1. CRUSHING INJURIES, USUALLY SUBCUTANEOUS

The instruments required for operations on the liver are, with few exceptions, those used in all abdominal operations. Especial attention is called by the editor to the great value of the aspirating or suction devices described in Vol. I, Chap. VII.

Indications.—In injuries of this type the right lobe of the liver is usually ruptured. The injury is caused most often by the wheel of a wagon passing across the body, in other cases by falls from a height, anl more rarely by blows.

Associated injuries are common, and the majority of these cases die without the chance of surgical intervention. Shock is also commonly severe. In the cases where shock is only moderate and the general signs and symptoms of **hemorrhage** appear and increase, operative intervention is called for at once.

A probable diagnosis can sometimes be made:

1. From the history of the accident, though this is often indefinite.
2. From signs of contusion and abrasion over the lower part of the right side of the thorax.
3. From pain, tenderness and rigidity in the upper right quadrant of the abdomen and possibly from increasing dullness in the right flank.

In many cases internal hemorrhage from rupture of some abdominal viscus in the upper part of the belly is all we can be sure of. Fractures of ribs over the liver, with signs of internal bleeding, suggest rupture of the liver.

If small tears only exist on the upper surface of the liver the bleeding may cease spontaneously and a hematoma may form between the liver and the diaphragm, which may be evacuated at a later date. In other cases of moderate severity blood and bile may accumulate in the general abdominal cavity, giving the signs of free fluid; these accumulations may also be evacuated through an incision, best by suction, as described in Vol. I, Chap. VII.

In some of these cases the blood is largely absorbed and its place taken by the bile. The results, if this condition is untreated, may be adhesive peritonitis, or, in others, abscess formation or purulent peritonitis. Nearly all these cases, if they live, become jaundiced.

Operative Technic.—A vertical cut is made through the outer third of the right rectus muscle, beginning near the free border of the ribs and extending downward a variable distance, but always far enough to admit the entire hand freely. The surgeon can thus explore the liver and other organs by sense of touch, and lacerations of the liver substance can easily be felt. If the liver is ruptured, free blood will be found in the abdomen, and, since such bleeding is very free, as a rule, no time should be lost in seeking its source. An assistant may in the meantime aid in the search by the use of the suction nozzle. As soon as found, with good retraction, the rent should be firmly packed with gauze. If it can be made visible, mattress sutures of heavy catgut may replace the gauze and stop the bleeding, or one or several such sutures may be used over the gauze. Although bleeding from the liver is very active, it is not hard to control by these means if the wound is accessible.

In the bad cases death occurs within 24 hours. If they survive this time, the chances of recovery are much better. If the bleeding is controlled, the abdomen should be emptied of blood by suction. The gauze packing, if used, is led out of the upper angle of the wound and the incision sutured in layers. In some cases the original wound must be enlarged to make the site of rupture accessible. The cut may be extended upward and inward parallel to the costal border; in other cases downward and outward.

2. Operations for Open Wounds: Stab and Gunshot Wounds

Associated injuries are more common with gunshot than with stab wounds. These cases should be operated upon at the earliest possible moment, for hemostasis and evacuation of blood or other fluid (bile). The position of the incision may be varied according to the portion of the liver probably injured. When the wound is found, the bleeding can be checked by the means already described; namely, packing or suturing or both. If necessary, a flap including ribs and their cartilages may be turned up to render the wound accessible. In one case I divided the falciform ligament of the liver to get at the stab wound of the dome of the right lobe by depressing the liver and raising the ribs.

The statistics of operations for injuries of the liver done in the hospitals of the City of New York during the decade of 1895 to 1905, collated by Tilton, showed a mortality of 44 per cent.

B. OPERATIONS FOR DISEASE OF THE LIVER

1. Abscess of the Liver

a. Pyogenic Abscess.—Pyogenic infection of the liver may be of 2 types and result in 2 different lesions:

1. Liver pyemia, a septic pylephlebitis of the branches of the portal vein secondary to emboli coming from the mesenteric veins, due most often to gangrenous appendicitis. The disease is not amenable to surgical treatment and is almost uniformly fatal. The liver is usually enlarged but not greatly. The abscesses are multiple and may consist of rather narrow, suppurating, and necrotic tracts surrounding the branches of the portal vein. Efforts to evacuate their contents are useless.

2. Abscesses arising from infective processes of the alimentary tract and its associated glandular organs, from injury to the liver, from ulceration due to foreign bodies, etc., or from a systemic pyemia. These abscesses may be solitary and demand operation as soon as their presence and location can be made out.

b. Amebic Abscess.—Amebic abscesses are the result of tropical dysentery, while the pyogenic group may run either an acute or chronic course; amebic abscesses are always chronic.

General Principles of Operative Treatment.—The treatment of both types of abscess is the same, early evacuation and drainage through an incision which gives promise of ready access to the abscess and is so performed as to diminish, as far as may be, the danger of contaminating other structures, such as the peritoneum and the pleura.

One caution is in order: No aspirating needle should be thrust into the liver in search of pus until everything is in readiness for following the needle instantly with a knife. By following this caution 2 risks will be avoided: unnecessary contamination of pleura or peritoneum and failure again to find the abscess after the needle has been withdrawn.

The choice of incision will vary in different cases. It may be abdominal or transpleural or a combination of these routes.

1. **Operation by the Abdominal Route.**—This method is indicated especially in the cases where the border of the right lobe of the liver is displaced downward, well below the costal margin in front, and when local tenderness, rigidity and perhaps edema render it probable that the liver is adherent to the parietal peritoneum.

A vertical cut is made exposing the liver at the chosen point. If the liver is adherent over a considerable area, the abscess may be sought for without more ado. If not, one of 3 plans may be followed.

1. The peritoneum may be protected by gauze packing or pads, and the abscess sought for.
2. The parietal peritoneum may be sutured to the liver, and the liver explored.
3. Packing may be introduced and opening of the abscess delayed for 2 or 3 days until adhesions have formed.

The first of these plans is the only one to be recommended.

If the operation is done in a hospital equipped with a suction apparatus, or if the surgeon is supplied with a portable device of this kind, the safest and best plan is as follows: A hand aspirating needle and syringe are used to locate the abscess. If it is of considerable size, a diminished sense of resistance to the advance of the needle may be appreciated as the needle enters the cavity and sometimes lateral mobility may be recognized. When pus appears, the needle is left in situ and a medium sized trocar and cannula attached to the suction tube are pushed alongside the needle into the liver until the level of the pus is reached. The trocar is then retracted and suction commenced. In this way the largest abscesses may be quickly evacuated with little or no soiling of the surrounding structures. When no more pus appears in the bottle, the trocar and cannula may be withdrawn and the aspirating nozzle shown in Figure 8 substituted. This may remove more pus and shreds of necrotic liver tissue. The opening into the abscess is then enlarged with the finger and perhaps septa may be felt and broken down.

A large soft rubber tube guarded by a safety pin at its outer end is introduced into the abscess cavity. The gauze packing is removed and replaced by a smaller quantity. One or more sutures may be used to diminish the size of the wound, usually at its lower end. A split gauze pad is applied to protect the skin from the pressure of the safety pin, and a voluminous dressing of shaken gauze applied. This will require frequent renewal for the first few days. Irrigation of the abscess cavity should not be made.

2. **Operation by the Transpleural Route.**—If the abscess has already burst into the pleura, there will be no choice of methods, both pleura and abscess must be drained. In other cases this route is indicated when there are physical signs indicating that the abscess is enlarging upward and backward, i. e. dullness, flatness, and absence of breathing over the lower part of the right chest behind. In my hands this has given better results than the abdominal route. The technic is as follows:

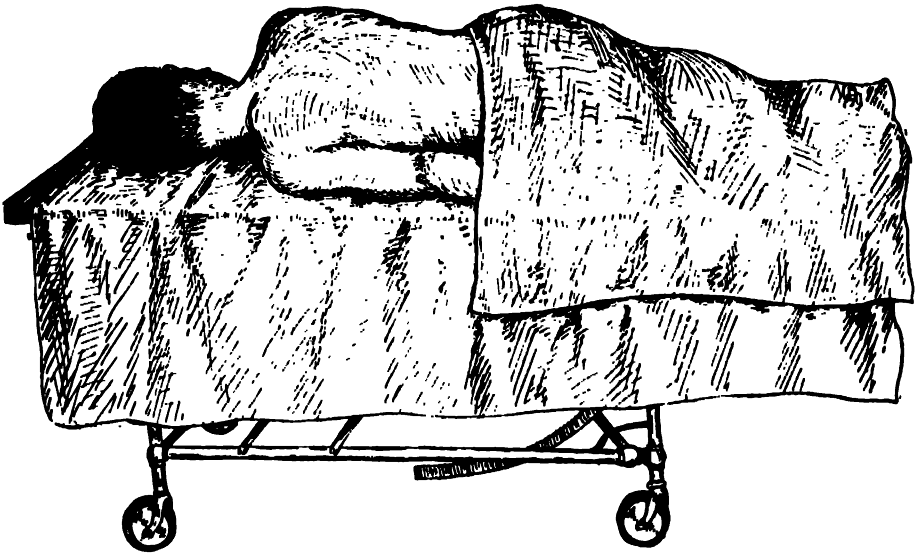

Fig. 1.—Patient on Table in Position for Opening Liver Abscess Posteriorly.

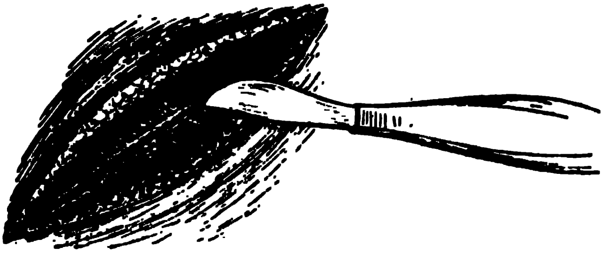

Fig. 2.—Skin Incision Over Rib for Opening Liver Abscess.

The patient is placed upon the table lying upon his left side (Fig. 1). Intratracheal anesthesia is desirable, though not essential. The ninth or tenth rib is exposed by a cut over it and parallel with it (Fig. 2), and a portion, 3 in., resected. I have not found it necessary to resect more than 1 rib, though some surgeons advise resection of 2 or 3. The pleura is then opened by a cut 2 to 2½ in. long. If intratracheal anesthesia is used, collapse of the lung need not be feared. In the cases I have done with ordinary anesthesia the diaphragm has bulged firmly up against the parietal pleura and no appreciable aspiration of air has occurred. The pleura is next closed off by a running suture of catgut uniting its costal and diaphragmatic layers (see Fig. 6).

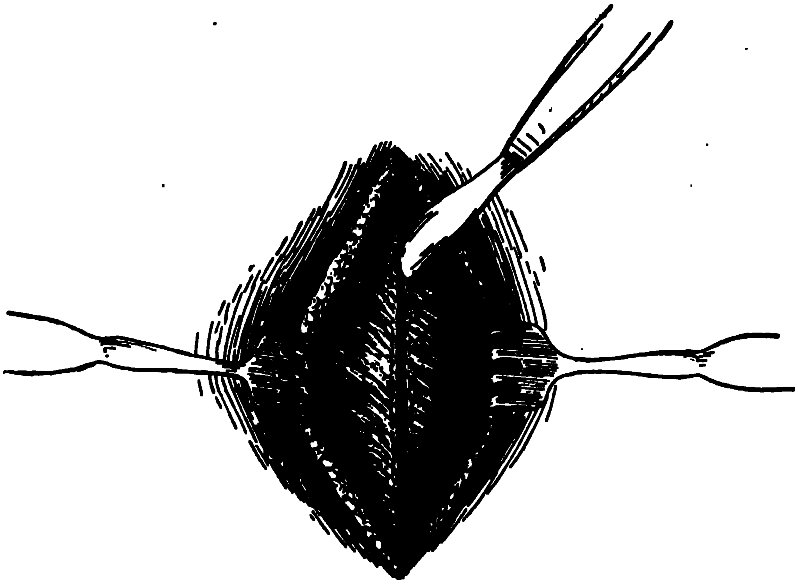

FIG. 3.—INCISION OF MUSCLES OVER RIB.

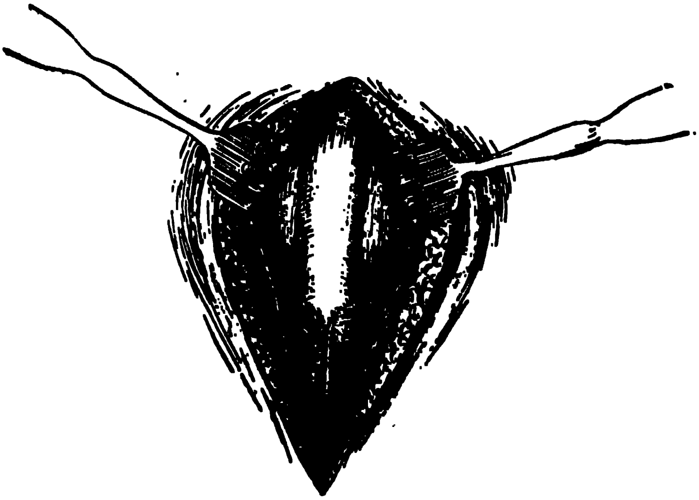

FIG. 4.—RIB EXPOSED AND DENUDED OF PERIOSTEUM.

The evacuation of the abscess is now accomplished in the same manner as in the abdominal route just described, except that the drainage opening passes through the diaphragm (Figs. 7, 8).

As previously stated, if the abscess has already ruptured into the pleura, this sac must be drained. The site of the perforation in the diaphragm must be found, enlarged and drained, also.

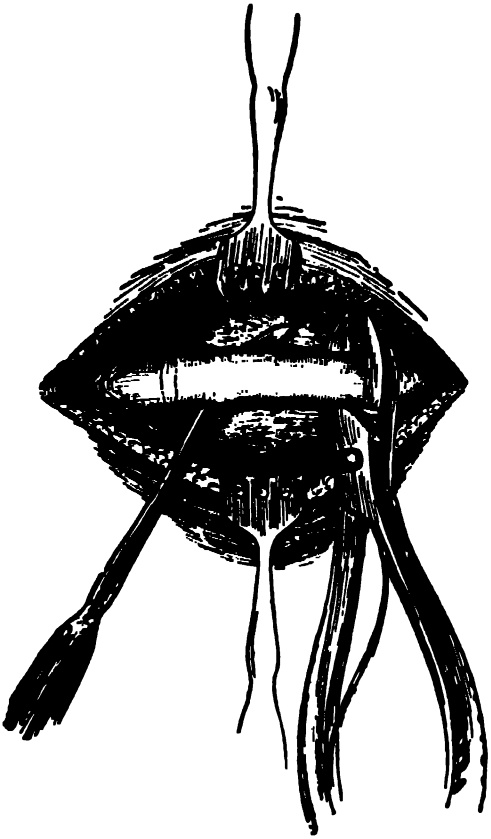

Fig. 5.—Elevator Beneath the Rib and Bone-cutting Forceps Applied.

3. Operation by Route Through the Abdominal Wall and Pleura.—In this operation the approach is through an abdominal incision in front and the effort is made to approach the abscess through the diaphragm without opening the pleura. This layer, when reached, is pushed away from the diaphragm by blunt dissection with the finger or with a sponge on a holder.

In these cases a vertical cut is made opening the peritoneal cavity just below the ribs. The cut is extended upward and portions of the several ribs are excised. A cut is now made through the diaphragm, the pleura pushed upward, and the abscess opened and drained as already described. If the

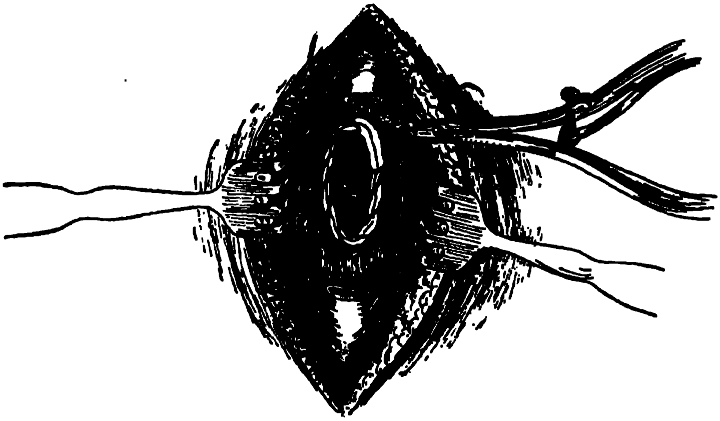

FIG. 6.—RIB RESECTED. Suture of pleura to diaphragm.

pleura cannot be pushed upward it is incised, and both layers are sutured to the edges of the wound in the diaphragm. The surrounding parts are protected by gauze packing and the abscess sought for, emptied, and drained. The lower part of the wound below the ribs is closed by sutures. If the abscess

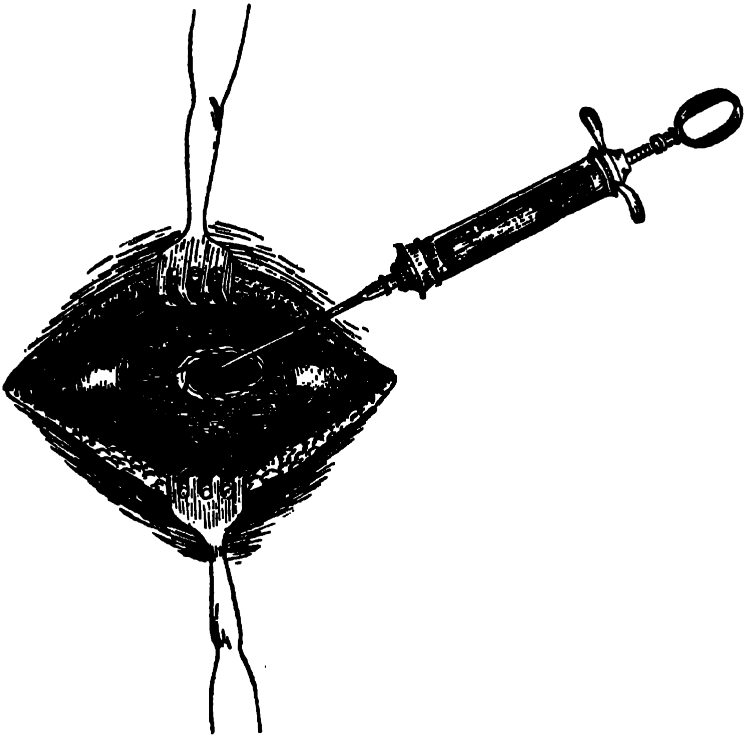

FIG. 7.—EXPLORING NEEDLE INTRODUCED THROUGH DIAPHRAGM INTO ABSCESS IN LIVER.

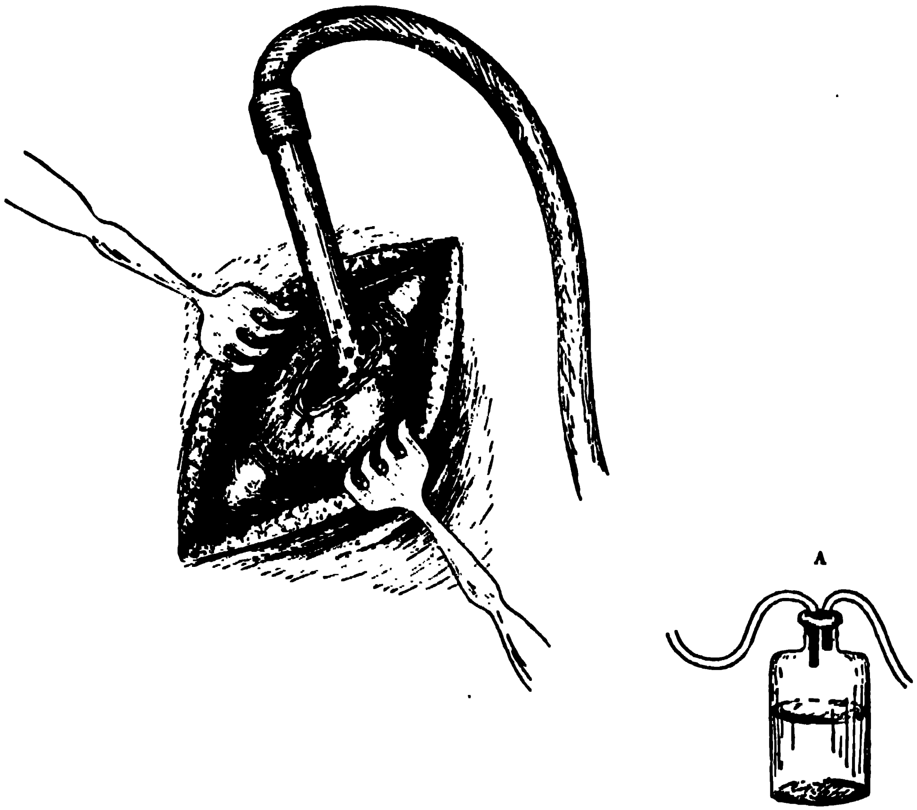

FIG. 8.—ASPIRATING NOZZLE IN ABSCESS CAVITY. A, Tubes in receiving bottle.

is of pyogenic origin, protection of the pleura from contamination is important; in amebic abscesses, where the pus is often sterile, it is less so.

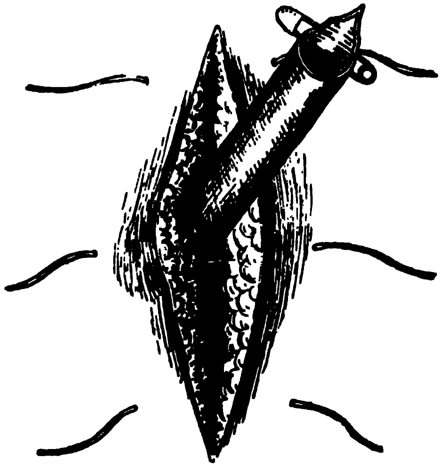

FIG. 9.—LABUS DRAINAGE TUBE IN ABSCESS. Sutures in position for partial closure of wound.

Prognosis.—The mortality in these cases has been greatly reduced by early operation and improved technic. It should not be over 20 per cent. In my experience it is higher in abscesses of pyogenic origin than in the amebic cases. In the former the patients are often acutely septic, the abscesses are often multiple, hard to reach, and harder to drain.

Actinomycosis and Tuberculosis.—The methods of operating in the rare cases of actinomycosis and tuberculosis of the liver do not differ from those described for pyogenic and amebic abscesses, except that these conditions are less often amenable to surgical treatment and that in actinomycosis the internal use of large doses of iodid of potassium may be curative.

Gumma.—Gumma of the liver is important from a diagnostic point of view. It does not require nor is it benefited by operation. Specific treatment is indicated.

2. Operations for Echinococcus Cyst of the Liver (Hydatids)

The operations for echinococcus cyst of the liver are 2 in number:

1. Evacuation.
2. Extirpation of the sac.

The former is the most commonly performed, although the latter is usually practicable. Two accidents may occur in cases of hydatids of the liver: rupture and suppuration. In either case the patient with an enlarged liver becomes much more ill and may die unless speedily operated upon. The indications are for an immediate operation as soon as a probable diagnosis is made.

Diagnosis.—This may be aided by the following data briefly enumerated:

Those who live in close contact with dogs are most apt to be infected.

Natives of Iceland, parts of Australia and Austria, and Icelanders who have migrated to Canada furnish the largest number of cases. The right lobe of the liver is, as a rule, involved. The enlargement is slow and may interfere with the general health only by pressure.

The tumor is smooth, rounded, and elastic. In some cases obscure fluctuation or the hydatid fremitus may be perceived upon palpation.

1. Evacuation.—The technic of the operation—incision, evacuation, and drainage of the sac—so far as exposure of the cyst goes, does not differ materially from that described under the discussion of abscess, except that a larger cut is required, large enough for the easy insertion of the hand into the sac. The cut is vertical over the most prominent part of the tumor.

The same caution obtains here as in abscess, whether the cyst is infected or not, namely, aspiration should not be practiced through the abdominal wall, nor until the moment when the cyst is to be emptied. The fluid, if spilled upon healthy parts, is capable of causing secondary infection with echinococcus.

The cyst having been exposed over its thinnest part, i. e. that covered by the thinnest layer of liver tissue, and the surrounding structures having been carefully protected by gauze packing, an aspirating trocar (Chap. VII, Vol. I) is introduced and the contents of the sac sucked out. When no more contents appear, the trocar may be removed and the **cupping nozzle** introduced. This will remove daughter cysts and with it even portions of the outer cyst wall may be brought away. The opening in the sac may then be enlarged and more material removed with the hand.

If it is determined not to attempt to remove the outer cyst wall, after the contents are removed as completely as possible with the hand or with gauze wipes or sponge holders, the edges of the wound in the liver are sutured with catgut to the edges of the wound in the parietal peritoneum. The cyst is thus completely closed off from the peritoneal cavity and is said to be marsupialized. The cavity in the liver is packed with plain gauze to which a soft rubber drainage tube may be added if desired.

A portion of the wound may be closed by suture. The packing in diminished amounts is continued as the cavity decreases in size and balsam of Peru packing may be used to stimulate granulation.

2. **Extirpation of the Sac.**—In this operation a more extensive incision is required both in the abdominal wall and in the liver. In some cases, where the cyst presents high up on the dome of the liver, it may be necessary to resect several ribs. The transpleural route has been used in some cases (see Abscess of the Liver).

The operation proceeds as before until the cyst is emptied. The cut in the liver is increased in size to give as free an exposure as possible of the cyst wall; retractors protected by gauze pads may be used in the liver wound. The sac is then enucleated by blunt dissection, with the fingers and gauze sponges on holders, aided by a pair of blunt-pointed, curved scissors if need be. Bleeding is usually not severe and may be controlled by pressure.

The cavity in the liver should be reduced in size as far as possible by catgut sutures. The wound in the liver surface is also closed, leaving a suitable space for the insertion of a drain; this may be of folded rubber tissue, a cigarette drain, or a short rubber tube, according to the needs of the individual case. The abdominal wound, except for the drainage opening, is closed by sutures and a large dressing applied. (A number of these cases have been treated by complete suture without drainage and without fatality. The practice does not appeal to me.—Editor.)

Prognosis.—The prognosis of these operations, even when the sac is suppurating, is quite good. If the sac suppurates and ruptures, it is much worse.

3. Operations for Cirrhosis of the Liver: Epiplopexy

Operations for cirrhosis of the liver are rarely of benefit except in the atrophic form of cirrhosis. Cases of atrophic cirrhosis may be divided into 2 groups: (1) Those due to the habitual use of excessive amounts of alcohol, very frequent; (2) those with no alcoholic history, very few in number. The former are usually people of middle age, though the disease may occur in the young. The latter are usually young adults. It is only in a small proportion of these cases that improvement occurs after operation. The number of fatalities is large, probably much larger than statistics indicate, since the successful cases are reported, while many of the deaths are not.

The operation is done for the cure or improvement of ascites by establishing a collateral circulation between the portal and systemic venous systems.

The operation is so dangerous that the patient and his friends should know that a fatal outcome is probable and that cure though possible is rare.

I have had 3 successful cases and many deaths.

One case was a woman with no alcoholic history, aged about 30 years. She had been tapped a number of times and was slightly jaundiced. She was so much improved by the operation that when I saw her 3 years later I failed to recognize her as the same woman. The Talma-Morison operation was done in this case.

The other 2 cases were middle-aged men and were alcoholic. One was improved, though I soon lost sight of him. The other returned at the end of a year much improved in health, with only slight ascites, to be operated upon for umbilical hernia, which had existed at the time of the former operation but had increased in size. He survived this operation and was well at the end of another year. Since then I have lost sight of him. The Schiassi operation was done in this case.

There are certain contra-indications to the operation of *epiplopexy*, among them, advanced age, marked cholemia, marked general debility, arteriosclerosis, chronic interstitial nephritis. When these conditions exist, the patients, if operated upon, usually die comatose in a few days.

The operation may be performed in one of 3 ways:

1. Talma-Morison operation.
2. Schiassi's operation.
3. Schiassi's operation modified.

It is to be borne in mind that the veins of the abdominal wall are dilated and that, though the operation is simple, free bleeding is to be expected. A general anesthetic is, therefore, required.

1. **The Talma-Morison Operation.**—An epigastric median cut is made, large enough to admit the hand. Most of the fluid is aspirated, and the upper surface of the liver and diaphragm scrubbed with gauze or a soft nail brush. The parietal peritoneum of the anterior abdominal wall is scrubbed with gauze; the omentum united to the anterior abdominal wall on either side of the wound, with numerous fine catgut sutures; and the wound closed without drainage.

2. **Schiassi's Operation.**—This operation I have performed only in a modified form. As used by the Mayos, it is performed in the following manner: A vertical incision is made close to the margin of the ribs downward through the rectus muscle in line with the epigastric and internal mammary vessels. The peritoneum is opened, the omentum found and pulled out. Some 4 in. below, another incision is made through the rectus but not through the

posterior layer of its sheath. The muscle is undermined upward to the first incision, the omentum is pulled down and spread out in the gap, where it is fixed by sutures, thus lying in contact with the epigastric vessels. Both superficial wounds are closed without drainage. The operation may be repeated upon the other side.

If fluid re-accumulates, it may be let out by suprapubic tapping.

3. **Modified Schiassi Operation.**—A modification of this operation, simple but probably less efficacious, is as follows (I used it in one of my successful cases):

A median epigastric incision is made 2 or 3 in. long. On either side of the wound the subcutaneous tissues are undermined for a distance of 2 in. The peritoneum is incised, the omentum pulled out, tucked into the undermined gap, and fixed with sutures. The peritoneum is sutured snugly around the omentum without constricting it, as is also the aponeurosis. The skin wound is sutured. The patient upon whom I performed this operation was alive and in fair health 2 years later. No hernia developed at the site of the operation.

OPERATIONS FOR TUMORS OF THE LIVER

The main difficulty in operating upon the liver itself is hemorrhage. A variety of plans and methods have been used for its control; some of them are here enumerated: Crushing the portion of the liver to be incised with heavy forceps, packing with gauze, hot wet compresses, the actual cautery, parenchymatous injections of boiling water, through-and-through interlocking sutures, mattress sutures, packing aided by sutures passed around individual vessels, and combinations of these methods to suit the particular case.

Wounds of the liver bleed furiously, and owing to the fragile character of the parenchyma, and the non-collapsible thin-walled veins, the usual artery forceps and ligatures cannot be applied. However, the blood-pressure is low in these vessels and moderate pressure or one of the devices enumerated above will suffice to check the hemorrhage in most instances.

The method used by the Mayos in the excising of portions of the liver is as follows (29):

> "Personally, we have found the following combination simple and safe. If the portion to be excised is thin it is crushed with the forceps and then cut away with the knife, followed by a hot, moist compress, which is held on the bleeding surface. With catgut on a round needle the liver margin is quilted back and forth. As much as possible of the gap is closed by sutures, and a pad of gauze of sufficient size to fill the remainder is introduced and the liver firmly compressed upon this by catgut sutures which produce sufficient tension to check the hemorrhage. As it loosens the gauze is removed, from the sixth to the twelfth day."

Benign solid tumors of the liver are rare and unless of large size do not require operation. Simple cystic tumors of the liver are observed. Mayo reports 2 of large size removed by operation and without great difficulty.

Adenomata of the liver are rarely observed. In a famous case reported by Keen he removed the entire left lobe with the cautery. Individual vessels were surrounded by catgut sutures.

A tumor situated near the free border of the liver may sometimes be removed by a wedge-shaped resection of the liver (Jacob Frank), the gap being closed by sutures or by a combination of sutures and packing.

OPERATIONS UPON THE BILIARY PASSAGES

CHOLECYSTOSTOMY

Cholecystostomy is the most frequent operation on the bile passages.

Indications.—Cholecystostomy is indicated for gall-stones in the gall-bladder or cystic duct; drainage of the gall-bladder in cases of cholecystitis; drainage of the bile in cases of cholangitis where the cystic duct is patent.

Instruments.—The instruments required in operations upon the bile passages are: the ordinary knives; scissors; thumb forceps, plain and toothed; artery forceps, ordinary and long, curved on the flat; retractors, sharp and abdominal, short and deep; needles and needle holders. In addition to these there are required 1 or 2 small sized lithotomy forceps such as are used in removing stones from the urinary bladder; the Robson scoop and the Finney scoop with malleable shank. I have found the weighted silk urethral bougies of several sizes sometimes useful in probing the ducts. They possess the advantage of not being likely to penetrate the wall of a duct and do damage.

The following list is that given by Wm. J. Mayo in Keen's "Surgery" (29):

1. Scalpel with "firm grip" handle.
2. Probe-pointed scissors curved on the flat.
3. Finney's gall-stone scoop with malleable shank.
4. Robson's gall-stone scoop.
5. Modified Blake gall-stone forceps.
6. Probe-pointed grooved director, malleable shank.
7. Ochsner's aspirating trocar.
8. Kocher director with eye in end.
9. Kelly gauze packer.
10. Malleable long probe.
11. Kelly needle holder.
12. Dibrell-Ferguson needle.
13. Murphy needle holder.
14. Medium Simpson retractor.
15. Deaver's long retractor.
16. Deaver's short retractor.
17. Pean's forceps.
18. Carmalt curved forceps.

This list of instruments of standard patterns suffices for most operations on the biliary passages. It may be modified to suit the taste and habit of the individual surgeon. In addition to the instruments, an aspirating device for emptying the gall-bladder and for other purposes is useful (see Vol. I, Chap. VII).

The operating table should have a central elevating shelf or a kidney air cushion or a large sand bag may be used in default of this. The first is best, since the position can be changed at will without disarranging the table. In stout persons especially the use of this elevator gives easier access to the gall-bladder and ducts. The table described in Vol. I, Chaps. I and II, is excellent.

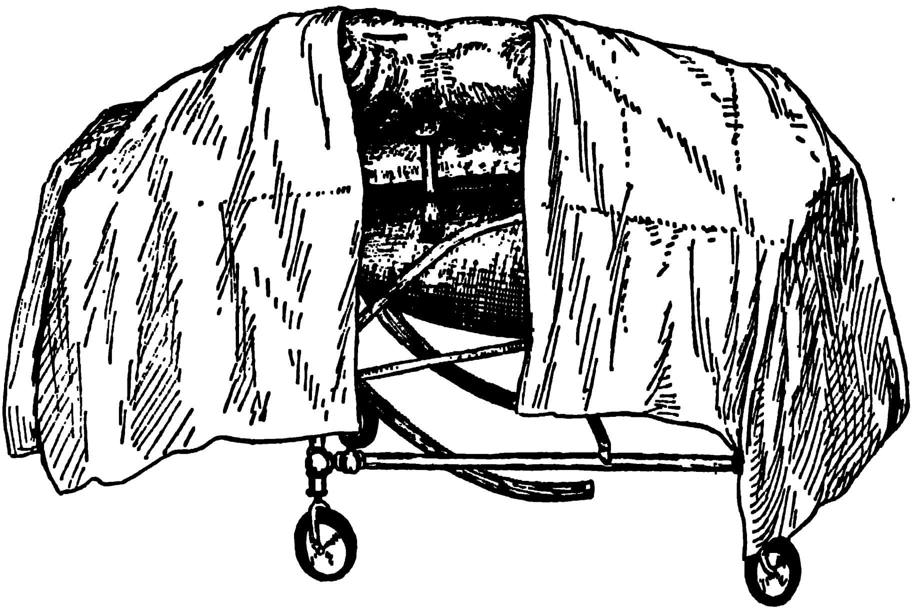

FIG. 10.—PATIENT ON TABLE IN POSITION FOR OPERATIONS ON THE BILIARY PASSAGES. Also position of vertical incision.

Technic.—When the gall-bladder is palpable, a vertical cut may be made over the tumor. The ordinary cut used by most surgeons is vertical through the outer third of the right rectus, beginning about an inch below the ribs. It is made 3 or 4 in. long and must be long enough to admit the entire hand with ease for palpation of the ducts, duodenum, pancreas, etc.

If the rectus fibers are separated carefully, the nerves crossing the line of incision may often be drawn upward or downward and spared. If, upon exploration, more room is required, the incision may be extended upward and inward, parallel to the free border of the ribs (Robson), or, in addition, downward and outward (Bevan). Kocher's incision runs parallel to the free border of the ribs; it possesses the disadvantage that if these wounds are drained anteriorly, as they always are in America, a hernia is not unlikely to

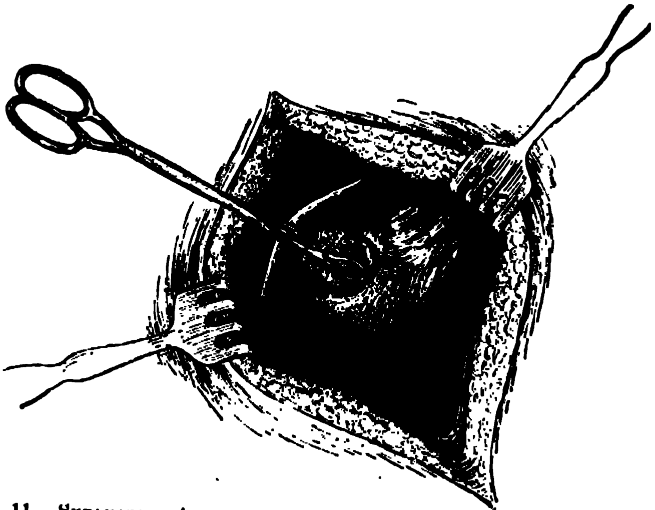

Fig. 11.—Separating Adhesions from Gall-bladder with Sponge Holder.

occur. If very careful suturing were done, with posterior drainage (Morison), this criticism might not apply.

In my experience the vertical cut has sufficed for nearly all cases (Figure 10). For exploration of and operations upon the deep ducts, where difficulties arise, the Robson modification of the Bevan incision, namely an exten-

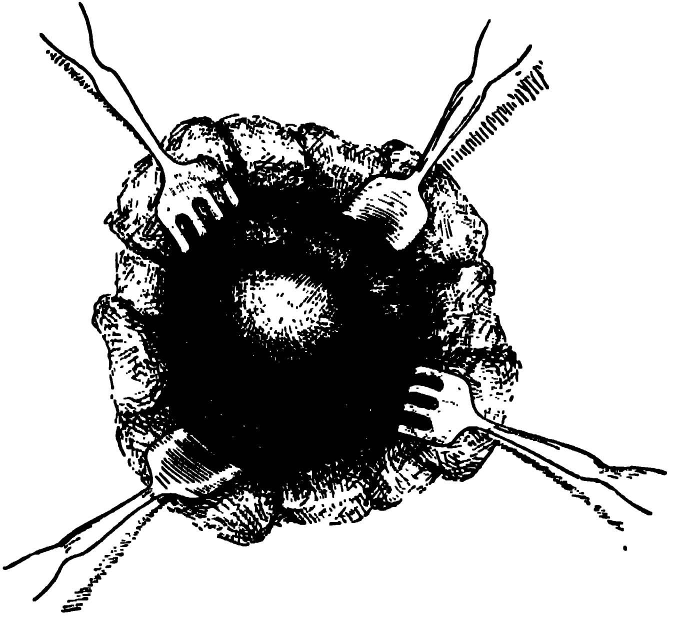

Fig. 12.—Gall-bladder Isolated by Gauze Packing.

sion of the vertical cut upward and inward toward and nearly to the median line and tip of the xiphoid cartilage, seems to enjoy the greatest popularity among American surgeons of the largest experience. This cut renders more easy the dislocation of the right lobe of the liver downward through the wound and then upward for easier work on the ducts, to be described later. The very large cuts used by some foreign surgeons are not necessary and have not become popular in America.

After the peritoneum is opened, the gall-bladder is sought for. If the case is one of intense infection of the gall-bladder and yet not of a character to indicate its removal and if many adhesions are present, it may in rare cases be wiser to separate only so many adhesions as will permit drainage of that viscus. In most cases the adhesions should be separated with the fingers or a sponge holder, or, if old and dense, with blunt-pointed dissecting scissors, bleeding areas being ligated, pressed upon firmly with gauze on a sponge holder or controlled by packing.

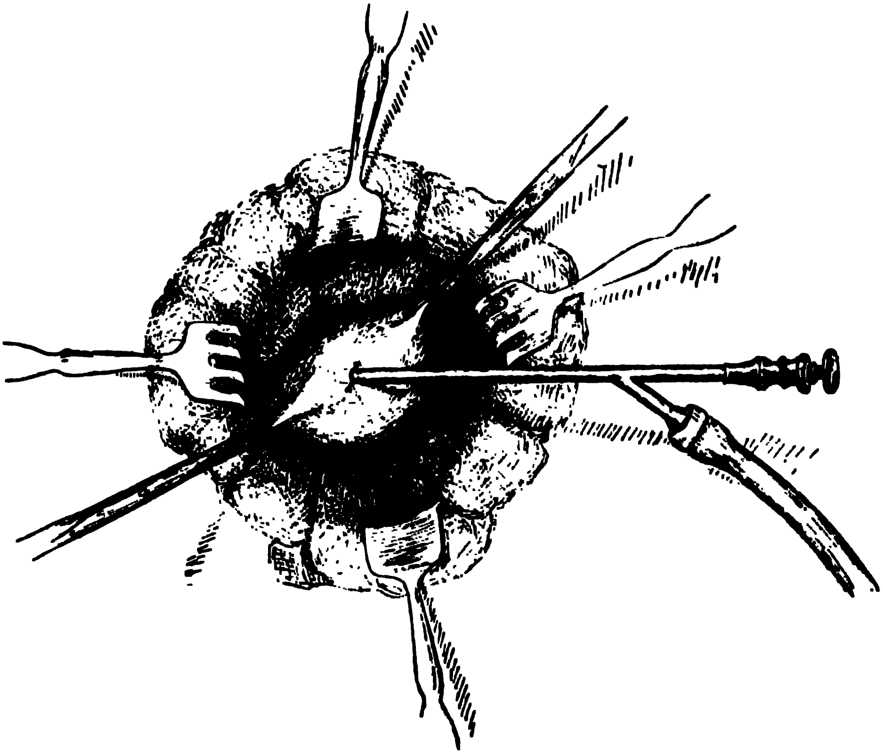

FIG. 13.—GALL-BLADDER HELD BY TWO PAIRS OF TISSUE FORCEPS AND ASPIRATING TROCAR INTRODUCED INTO FUNDUS.

The gall-bladder is inspected and palpated, next the cystic duct. The whole hand is then introduced into the belly and with the forefinger and thumb (I use the left hand) the common duct, the head of the pancreas, the hepatic duct, and duodenum are palpated gently and carefully. Thus the presence of stones in the cystic duct or the common duct may often be detected. The presence of pancreatitis, as evidenced by enlargement and induration of the pancreas, may also be felt. It is not always possible to feel stones in the common duct nor to tell their number in this way, but with practice much valuable information may be obtained. If there is any doubt about the diagnosis, other organs, the spleen, the kidneys, the stomach, etc., may be examined by touch.

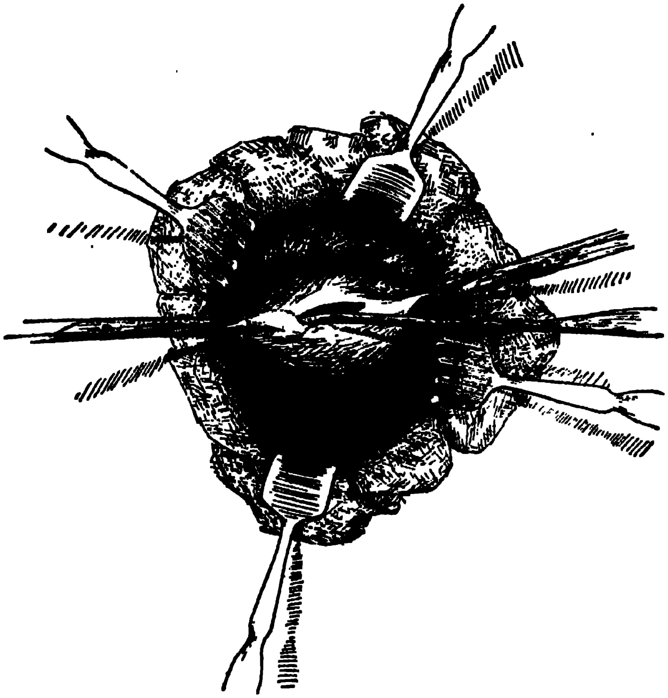

Fig. 14.—Scoop in Gall-bladder Searching for Stones.

The operation of draining the gall-bladder having been decided upon, the intestines and stomach are pushed out of the way with tailed pads and held by deep retractors (Fig. 12). Packing is also liberally introduced into the right kidney pouch to prevent soiling. The dome of the gall-bladder is then seized with 2 pairs of Kocher artery clamps or 2 pairs of tissue forceps (Fig. 13). The aspirating trocar is plunged into the gall-bladder between the forceps and its fluid contents removed as far as possible (Fig. 13). The gall-bladder is then opened with a knife, the incision being large enough to admit the scoop easily (Fig. 14).

Stones are sought for and removed with scoop and forceps. When deeply placed in the cystic duct they may be difficult to extract. Blake's forceps is useful in such cases. If impacted, they may often be dislodged with the finger and thumb of the left hand introduced into the abdomen. **The cupping nozzle of the aspirator is often very effective in removing small stones** (Chap. VII, Vol. I). If all these measures fail choledochotomy must be performed (to be described later). After all stones are removed, the interior of the gall-bladder may be wiped clean with narrow gauze packing introduced with a long thumb forceps or a large probe.

A purse-string suture of fine chromic gut on a curved needle is inserted through all coats of the gall-bladder around the margin of the opening in its fundus (Fig. 15). A drain composed of a rubber tube ¼ to ⅓ in. in diameter wrapped in a few layers of plain or iodoform gauze, and this in turn wrapped in heavy rubber tissue, is introduced into the gall-bladder and the purse-string suture tied firmly around it (Fig. 15). A second purse-string suture of the same material is then passed outside the first; this suture does not include the mucous membrane.

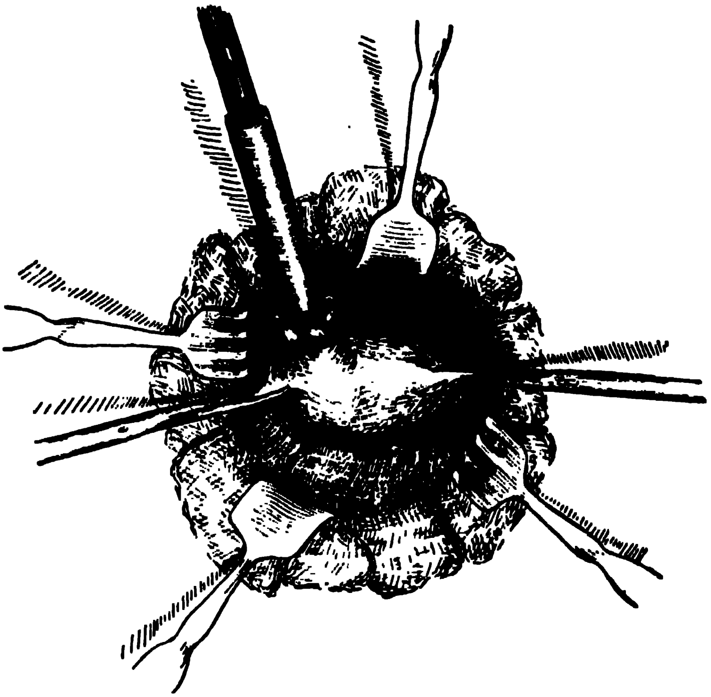

FIG. 15.—PURSE-STRING SUTURE THROUGH ALL THE COATS OF THE GALL-BLADDER SURROUNDING A DRAINAGE TUBE PROTECTED BY RUBBER TISSUE AND GAUZE.

While an assistant pushes the tube toward the cavity of the gall-bladder, the second suture is tied, thus invaginating the gall-bladder around the tube (Fig. 7). A single plain gut stitch may be used to anchor the tube to the fundus of the gall-bladder, though I sometimes omit it. Instead of a rubber tube wrapped in gauze and rubber tissue, a red rubber tube may be used alone and as well. It should have a sleeve ½ in. long of larger tubing. A stitch of plain gut anchors the sleeve to the fundus of the gall-bladder.

With this technic it is not necessary to use an additional drain for the abdominal wound unless extensive soiling with highly infectious material has occurred. If the gall-bladder is reasonably healthy, it is not necessary to

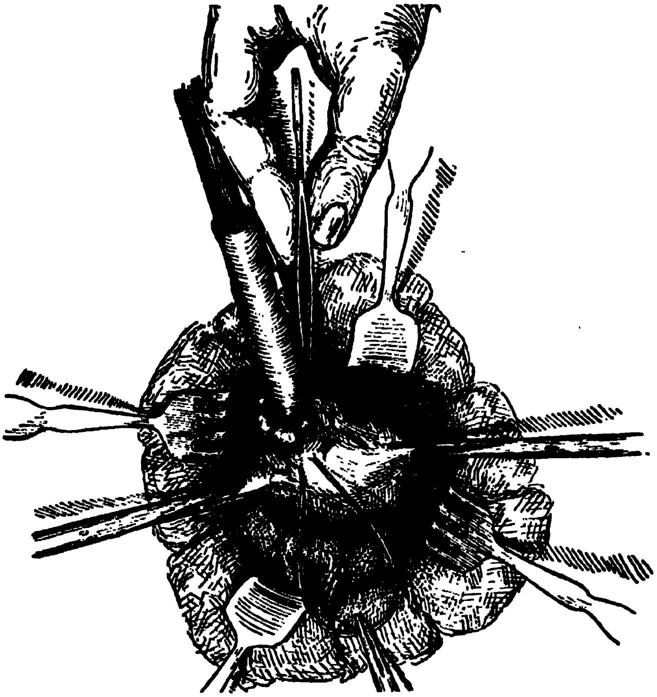

FIG. 16.—SECOND PURSE-STRING SUTURE PASSED AND READY TO TIE.

attach it to the abdominal wall. If, however, the contents of the gall-bladder are foul and appear to be very infectious and if the whole process is acute, it is better not to invert the fundus around the tube but to anchor the tube to the aponeurosis of the abdominal wall at the upper angle of the wound, since, if the drainage is removed early, after 7 or 8 days, a new infection may occur and a re-accumulation of pus and bile in the gall-bladder take place, with severe pain and constitutional symptoms, fever, jaundice, etc. If the tube is thus anchored, the pus will readily find its way to the skin surface, avoiding another abdominal incision.

It is highly important to lead the drainage tube from the upper angle of the wound; the formation of a biliary fistula is less likely to occur (Fig. 18).

The Mayos recommend in acute cases further drainage by means of a large split rubber tube enclosing the gall-bladder, the split toward the liver. This prevents adhesions to the gut, prevents the spread of infectious material, and

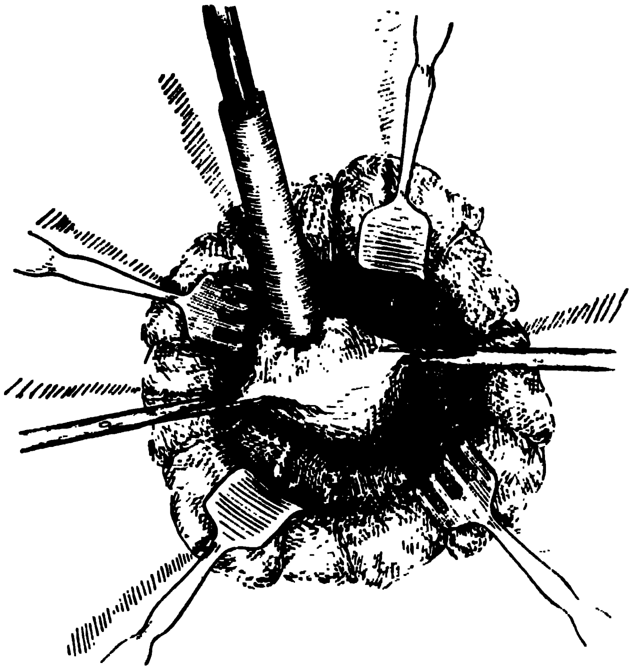

FIG. 17.—SECOND PURSE-STRING SUTURE TIED INVERTING THE GALL-BLADDER AROUND THE TUBE.

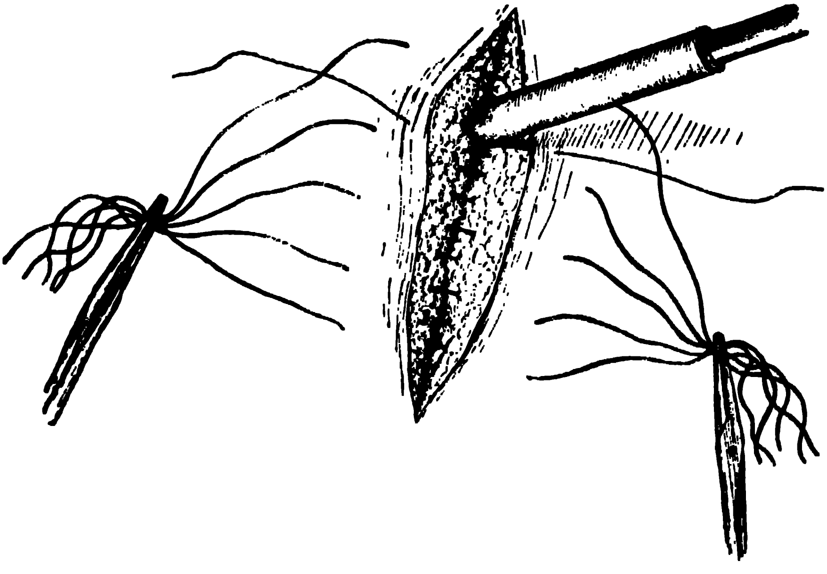

FIG. 18.—SUTURES IN ABDOMINAL WALL PASSED READY FOR TYING.

leads such material to the surface. I am in the habit of using a cigarette drain of gauze and rubber tissue just below the gall-bladder drain for a few days when I fear infection.

Partial Cholecystectomy.—In certain cases areas of necrosis or gangrene may be found in or near the fundus of the gall-bladder. These may be cut away with scissors and the remainder of the gall-bladder used for drainage. In other cases the gall-bladder may be so buried in adhesions that it is safer to remove the mucous membrane with scissors and curet rather than remove the entire gall-bladder. After drainage is established, the tube is brought out of the upper angle of the wound and the remainder closed by sutures in layers in the usual manner.

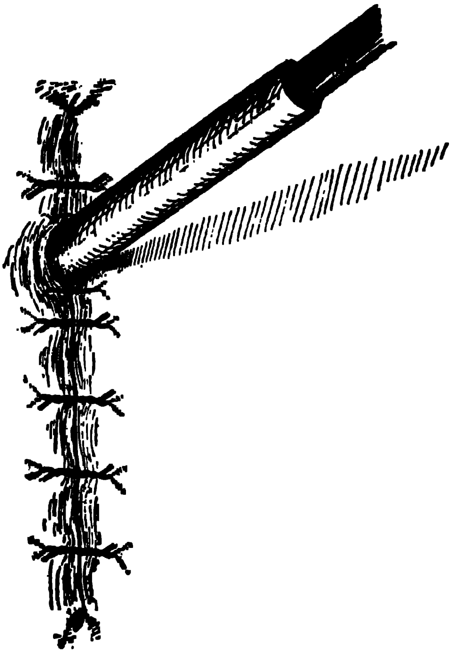

FIG. 19.—SUTURES TIED. (N.B. The drainage tube should have been drawn emerging from the upper angle of the wound.)

Drainage.—The time a tube should be left in the gall-bladder for drainage is from a week to 10 days in the average case. The Mayos consider that prolonged drainage favors re-infection. It certainly delays healing. Usually at the end of a week drainage has accomplished its purpose.

Results.—The results of cholecystostomy are good; the mortality in uncomplicated cases varies in the statistics of different operators. It has been greatly diminished in recent years by improved methods and should be less than 2 per cent. The Mayos estimate it at 1½ per cent.

Variations in Technic.—The above described technic answers for ordinary cases, but it may be necessary to vary it. I canont do better than quote these variations as described in an article by Wm. J. and Chas. H. Mayo in Keen's "Surgery" (29).

"*First.* If the gall-bladder be very short and shrunken, and it is desirable to save it, a tube is introduced into its cavity and the gall-bladder stitched to and around it without inverting the edges. Several of these sutures should grasp both the gall-bladder and the gauze and rubber tissue, holding it firmly in position. Four strips of selvaged 2-inch gauze are now sutured, each with a fine catgut suture, to the gall-bladder, just below its cut margin. The suture grasps the bit of gauze 1 inch from its end and the gall-bladder, and is tied between the gauze and the gall bladder. On the liver side it is tied closely into the margin of the notch. The deep end of the gauze is now tucked down so that it surrounds the opening in the gall-bladder like a shirting, while the outer end comes up out of the wound about the tube at the upper angle. The remainder of the abdominal incision is closed in the usual manner.

"*Second.* It will sometimes be found that the gall-bladder has very rigid walls, infiltrated by recent infection, and so adherent as to become partially extraperitoneal. In this case a tube is introduced into the gall-bladder and around it is packed iodoform gauze, so that there will be no dead space.

"*Third.* A gall-bladder may lie far to the outside, underneath the right lobe of the liver; the drain should then be brought out of the loin through a counter-incision, after the plan of Morison.

"Morison has shown that there is a considerable-sized pouch in front of the right kidney which in some subjects will contain a pint of fluid before it will overflow into the abdominal cavity. Brewer has shown that the capacity of Morison's pouch varies, and is largely determined by the height of the peritoneal attachment of the ileocecal intestinal coil to the ileum.

"*Fourth.* In subacute infections, the thin-walled gall-bladder is greatly distended with bile, foul-smelling from colon infection. There is a great tendency for recurrence of the symptoms at a later date; after much suffering, the fistula will reopen and evacuate the contents of the distended and obstructed gall-bladder. For this reason the gall-bladder should be sutured to the exterior aponeurosis of the rectus muscle instead of to the peritoneum. This forms a fistula which is much slower to heal, and in case of relapse the discharge readily works its way to the surface."

CHOLECYSTECTOMY

Some years ago the removal of the gall-bladder was recommended by a large number of American and other surgeons almost as a routine measure in cases of cholecystitis, whether associated with gall-stones or not. A few years later a change of opinion occurred in favor of saving the gall-bladder whenever possible. At present, removal of the gall-bladder seems to be gaining in popularity and is practiced by many surgeons with increasing frequency.

Indications.—The indications for cholecystectomy are permanent closure of the cystic duct and a functionless gall-bladder; stone impacted in the cystic duct; chronic inflammation of the gall-bladder, the so-called "strawberry gall-bladder"; dense hard inflammatory thickening of the gall-bladder; atrophied gall-bladder; cancer of gall-bladder when operable; total gangrene of the gall-bladder.

Technic.—The incision is made in one of the ways described under "cholecystostomy." The gall-bladder may be removed in one of 2 ways. The dissection may be made from the fundus toward the cystic duct or from the duct toward the fundus. The latter is the better method in most cases. It is easier and, since the cystic artery is clamped at the start, there is less bleeding.

In removing the gall-bladder and in operations upon the deep ducts it is advantageous to depress the liver and by traction on the gall-bladder and liver border to drag the liver partly out of the wound and then turn it upward on the abdominal wall (method of Robson). By this procedure the gall-bladder and ducts are rendered much more accessible, and procedures otherwise most difficult may be carried out with comparative ease. To remove the gall-bladder, beginning at the duct, the peritoneum covering the duct at or near the point of obstruction is incised in a circular manner and stripped back a short distance. The cystic artery is then sought for and clamped. A second clamp is placed upon the duct at the same level, or more commonly both are clamped together. A third clamp is placed distally upon both duct and artery. Between the clamps, duct and artery are divided with scissors. The peritoneum covering the gall-bladder is incised in such a manner as to create 2 lateral flaps of peritoneum large enough to cover in the raw surface of the liver after the gall-bladder has been removed. These flaps are stripped back by blunt dissection. With the finger tip, beginning at the divided cystic duct, the gall-bladder is gently teased away from the liver, working toward the fundus, until it is removed. Bleeding may be controlled by hot wet packing or, in some cases, by suture. The lateral flaps of peritoneum are now sutured together with catgut, covering the raw surfaces of the liver.

The cystic duct and artery are now ligated, using heavy catgut for the former, and the clamps are removed. A cigarette drain, or better a split rubber drainage tube containing gauze, is introduced and sutured by a catgut stitch to the stump of the cystic duct. After proper toilet, the pads are removed, the viscera carefully adjusted in the proper relations, the drain led out of the wound, usually at its upper angle, and the remainder of the wound closed by sutures.

If the cystic duct is very fragile, as sometimes happens, the clamp on its stump may be left in place surrounded by loosely wound gauze packing. This furnishes good drainage and does away with the danger of the ligature cutting through or slipping, with consequent leakage. This clamp may be left in place 2 or 3 days. In removing it, it should be gently unlocked and left in place for a few hours, so that the tissues in its bite may separate themselves from the jaws without danger of tearing open the mouth of the duct. A small tube may take the place of the clamp for a few days longer, protected by a split rubber tube.

In some cases, where the surgeon suspects there may be obstructive inflammation in the common duct, though no stone is found, it may be wise to tie the cystic duct with chromic gut or silk, leaving the ends long. Then, if damming of bile occurs in the common and hepatic ducts, the ligature may be pulled away at any time, permitting the pent-up bile to escape.

In cases of cancer of the gall-bladder, a wedge-shaped section of liver tissue should be removed with the gall-bladder and the bleeding should be checked by sutures or packing or both.

Results.—The mortality after cholecystectomy is slightly greater than after cholecystostomy, probably from 2 to 3 per cent. The operation is a somewhat more extensive procedure and is done, as a rule, for the more serious lesions.

One of the most serious possibilities following the removal of the gall-bladder is the formation of scar tissue in the vicinity of the common duct, compressing and occluding it with production of chronic jaundice. I succeeded in relieving 2 of these cases by dissecting away the scar tissue. The operations were tedious and difficult.

CHOLEDOCHOTOMY

Indications.—Incision of the common duct is indicated for the removal of stones in the common and hepatic ducts and for drainage of infected bile in cases of cholangitis when the cystic duct is wholly or partially occluded.

To be successful free drainage of the bile from the duct to the surface is the most important factor.

The prognosis is better if the operation is done during a remission of the jaundice, such as occurs in cases of ball-valve stone, or after the jaundice has become chronic, rather than during a period of acute and absolute obstruction. We are here sometimes "between the devil and the deep sea," since cases of chronic jaundice often bleed in an uncontrollable manner.

Technic.—REMOVAL OF THE STONE.—When a stone or stones are felt in the common duct, the surgeon, with his left forefinger and thumb grasping the duct, attempts to work the stone into that portion of the common duct which is accessible above the duodenum. When this is done, the stone, firmly held between finger and thumb, is cut down upon by a small longitudinal incision through the wall of the duct. The cut should be barely large enough to permit extrusion of the stone. When extruded, the stone should be carefully removed with forceps. Surrounding structures should have been carefully walled off and a suction apparatus should be in readiness to remove the bile, If other stones are felt, they are removed in the same way or with a scoop or Blake's stone forceps, in case the duct is sufficiently dilated.

In all cases the common and hepatic ducts should be carefully explored with the scoop for other stones, and the patentcy of the papilla should be tested with a flexible probe passed down the duct and through the papilla. A scoop should be passed down the common duct and all stones or fragments of stones gently and most carefully removed. In many cases the ducts are dilated to a size admitting the finger, which should then be used as an exploring instrument and as a piston to dislodge and coax other stones within reach; this is particularly true of **stones in the hepatic duct.** When the finger feels a stone in the common duct and it cannot be dislodged with a scoop, the following measure may be tried: The left forefinger and thumb grasp the duct below the stone and strive to push it forward; the right forefinger acts as a dilating guide and a stone may often be dislodged in this way.

DRAINAGE.—In these cases, as stated, **free drainage of the ducts from the liver to the surface is very desirable.** The Mayos' description of their method is excellent and is here quoted (30).

"Drainage of the common duct is best accomplished by passing an English catheter with the end cut off and a lateral eye about one inch below the cut end for side drain-

> **age. The catheter should be passed into the main hepatic duct in such a manner that it shall project up into the right hepatic duct, which is continuous with the main hepatic and common ducts. The eye should be turned toward and placed in front of the left hepatic duct. The catheter is then sutured to the upper angle in the incision in the common duct with a fine catgut suture; the *holding* catgut suture should be placed in the catheter with the ends left long before introducing the catheter into the hepatic duct. By threading each end of the suture into a needle after the catheter is in position it is readily held in place within the duct by passing the threaded needles from within out on each side and tying. The catgut will be absorbed before it is necessary to remove the catheter. The duct is closed about the catheter and the neighboring peritoneum is drawn over the suture line. The size of the catheter used should be in proportion to the size of the duct. A large split-rubber drain is placed about the catheter. The right side of this drain is left 1 inch longer so that the longer end will project down into the Morison pouch in front of the right kidney.**
>
> **"In patients very sick from cholangitis, a free discharge of bile to the surface is essential. In such cases the common duct should be opened without regard to whether or not it contains stones. The most common cause of death following the operations upon the gall-bladder and bile tract is failure to secure free drainage of bile to the surface."**

In the average case of common duct drainage the catheter is left in place after the other drains have been removed, i. e. about 10 days.

REMOVAL OF STONE BY THE TRANSDUODENAL ROUTE.—Stone impacted in the duodenal portion of the common duct, in the ampulla, which cannot be removed in any other way may be removed through the transduodenal route. The operation was devised by the late Doctor Charles McBurney and is known as the operation of "Duodenocholedochotomy." It was used by Doctor McBurney in many cases most successfully.

It may be thus performed: After the usual incision and exploration, it having been determined to use this method, the surrounding structures are carefully walled off with pads or rolls of gauze, leaving only the upper 4 in. of the duodenum and the pylorus exposed. The surgeon seizes the stone between the thumb and the forefinger of the left hand, the forefinger having been inserted behind the duodenum through the foramen of Winslow. The stone is then lifted forward against the anterior wall of the duodenum, and the bowel is incised vertically to the extent of about an inch or more over it. The contents of the duodenum are carefully wiped away. The stone can usually be seen through the tense mucous membrane of the wall of the bowel just above the papilla. The edges of the incision in the gut are gently held apart by an assistant, with forceps, and the stone cut down upon through the mucous membrane of the posterior wall and removed with forceps. Dr. McBurney, whom I assisted many times at this operation, usually sought the papilla and dilated or cut it and removed the stone by that route with forceps. If the stone was too large, he incised the papilla in an upward direction sufficiently to remove the stone.

The stones having been removed, other stones are sought for above with the scoop. The incision in the duct, if such has been made, requires no suture.

The incision in the anterior wall of the duodenum is closed with 2 rows of fine catgut sutures, or linen or silk thread may be used for the outer layer, and the abdomen is closed without drainage. If the common duct has already been opened and drained, the drainage tube may be left in place, or if there is reason to believe that small stones or débris occupy the common duct, narrow gauze packing may be passed down the common duct and out through the papilla, thus cleaning the duct completely.

Cancer of the papilla in its early stages has been removed successfully through this route. These cancers, in the removable stage, are small tumors of stony hardness; they are often mistaken for an impacted stone until incised.

CHOLECYSTENTEROSTOMY

Union between the gall-bladder and the intestine is one of the rarer operations upon the bile tract and is used to divert the bile from the common duct into the intestine when the former is obstructed in a way which cannot be overcome. The operation may be curative, or only palliative, as in some cases of cancer of the papilla. In these last the mortality is very high. This operation is also indicated in cases of permanent biliary fistula of the gall-bladder, when most or all of the bile escapes through the skin opening.

If possible, the gall-bladder should be joined to the duodenum, though jejunum or even colon or stomach may be used if union to the duodenum is impracticable.

The union may be made by suture, exactly as in gastro-enterostomy, or by means of a small Murphy button. The former method, though more troublesome, has the preference, since it is safer and occupies only a little more time.

Union by Suture.—Free the gall-bladder and duodenum from adhesions, if such there be, so that they can be brought together, and isolate them by suitable pads or packing. The incisions in gall-bladder and intestine should be about 3/4 in. to 1 in. in length. The gall-bladder should first be aspirated of its contents and, after opening, search should be made for stones with a scoop.

For uniting the orifices clamps are not necessary. The orifices are united by a double row of fine sutures precisely as in gastro-enterostomy. The inner row may be of **catgut**, the outer of **Pagenstecher linen thread.**

Union by Button.—If a button is used, the suture line should be reinforced with a few interrupted linen mattress sutures placed close to the bite of the button. A piece of omentum may be attached around the suture line and the abdominal wound closed unless much soiling has occurred, when, as a precaution, a cigarette drain may be left in the abdomen. The use of the Murphy button saves a little time, but it is open to the objection that the button may remain in the gall-bladder indefinitely and cause irritation or favor stone formation.

Union with the Jejunum.—*If union cannot be made with the duodenum on account of adhesions and the jejunum be selected for anastomosis, it is desirable, after intestine and gall-bladder are united, to do a lateral anastomosis between the limbs of the coil of jejunum (Mikulicz).*

Union with the Colon.—Theoretically, to unite the gall-bladder to the colon would seem to court disaster; as a matter of experience, however, the immediate results of this operation are good. The operation is easily performed, since the hepatic flexure of the colon and gall-bladder are normally in contact. The union may be made by suture or button as already described. This method is never used when union with the duodenum is practicable, since infection follows after a time.

AFTER-CARE OF GALL-STONE CASES

In addition to the ordinary measures used after all abdominal operations, certain special features obtain in gall-stone cases that require mention.

Bleeding.—As is well known to all surgeons, in cases of long-standing deep jaundice, more especially in victims of malignant disease—but yet not confined to this class—bleeding of a serious or even a fatal character may follow the operation either immediately or after several days. Such bleeding is believed to be due partly to changes in the blood-vessels and partly to delayed coagulation of the blood. We can do nothing for the former; for the latter several measures may be used, though we must confess that they are of rather doubtful value.

When obliged to operate on a patient with chronic jaundice we may seek to hasten the coagulation time of the blood by the internal administration of calcium lactate, gr. xv, t. i. d., by intravenous injection of horse serum, or by blood transfusion. I am not aware that any material benefit has ever been derived from these procedures, and yet I have used them in many cases, and the deaths have been few after 20 years and more of this work, and the recoveries many.

I have, however, never saved a case when bleeding has occurred several days after operation. These cases have all bled to death, after hours or days, in spite of every effort, local and general.

After the coagulation time has been measurably shortened by one or other of these measures, we may operate with perhaps a diminished risk. If blood transfusion has been successfully performed, it is better to operate at once rather than to delay even 24 hours.

Administration of Water.—Following gall-stone operations the Murphy drip is often useful. If the rectum is intolerant, the water may be introduced through the gall-bladder or common duct drain, after waiting 48 hours for adhesions to form, thus avoiding the danger of leakage. Water also may be introduced by other known methods.

Care of Stomach.—After gall-stone operations careful watch should be kept of the stomach, and gastric lavage should be practiced at any sign of an accumulation of stomach contents.

Removal of Tubes and Sutures.—A tube in the gall-bladder should be removed at the end of a week. A tube in the common duct at the end of 10 days; cigarette drains can usually be removed in 48 hours or 3 days, stitches in 6 or 7 days, superficial stitches in 5 days.

Favorable cases may be up in 14 or 15 days.

Biliary Fistulæ.—Persistent biliary fistula may be due to a stone left in the gall-bladder or in the common duct; such stones should be removed. Chronic pancreatitis may keep a fistula open by pressure. In such a case prolonged drainage of the gall-bladder is the best means of cure. Anchoring the gall-bladder at the lower angle of the wound may also cause a fistula to persist.

REMOVAL OF CANCER OF THE COMMON DUCT

I have had no personal experience in removing cancers of the common duct. In regard to these operations the Mayos write as follows (29):

> "The typical carcinomatous tumor of the common duct is a hard, grayish-white, well-defined growth, which during the operable stage will seldom be found larger than the terminal joint of the forefinger. It is of such stony consistency that it is sometimes mistaken on exploration for a stone, until incision determines its true character. In two-thirds of the cases the neoplasm will be found in the terminal portion of the common duct, and if seen sufficiently early, may be removed by the transduodenal method, after the plan described for the removal of stone. Several interrupted catgut sutures, so placed as not to permit of interference with drainage, should be introduced to close the defect. Successful operations of this kind have been reported by Halsted, Edes, Robson, and Mayo.
>
> "Carcinoma higher up in the common duct should be directly excised, if possible. The duct should be anastomosed by end-to-end catgut sutures, leaving a defect in the suturing on the anterior-inferior margin to permit of drainage. A small number of successes have been reported by Moynihan and others. Three operations by the writers gave two recoveries and one death.
>
> "If the excised section of the common duct is too long to permit of end-to-end union, the distal end is ligated and the proximal portion re-implanted in the duodenum in a situation where the intestine is entirely covered by the peritoneum. We have practiced two methods in carrying this out.
>
> "The simpler method is to make a working incision 1 inch long in the duodenum, through which a pair of curved forceps is introduced and made prominent at the site of the proposed anastomosis. A small incision is here made, the forceps passed out, and the cut end of the duct caught. This is drawn slightly within the lumen of the duodenum and two catgut sutures introduced laterally between the duct wall and the duodenum. By slight traction on the forceps, the walls of the duodenum and the duct are advanced into the intestinal lumen, ¼ inch, forming a nipple, and three catgut and one fine linen sutures are introduced between the outer coats of the duodenum and the duct, holding it firmly in position. Rolled rubber tissue drainage is intro-

duced if the field has been soiled. After closing the working incision in the duodenum the abdominal incision is closed to the drains.

"*The Second Method.*—When the duct is greatly dilated, an elliptic piece may be removed from the side wall of the duodenum where it is entirely covered with peritoneum, and the dilated duct sutured to this orifice by two rows of catgut sutures in the same manner as a gastro-jejunostomy is performed. The outer row of sutures is placed first, penetrating the outer walls of the duct and duodenum, behind, through-and-through catgut suture is carried all the way round and the outer row brought forward to the starting point. In one case we were able to use this particular method of anastomosis between the hepatic duct and the duodenum, after removal of the entire supraduodenal portion of the common duct, with success.

"Operations for strictures of the common duct are sometimes required. Two methods are available:

"*First,* complete division of the duct proximal to the obstruction and re-implantation of the duct end into the duodenum; *second,* and preferably, by cholecystenterostomy, if the gall-bladder and cystic duct are sufficiently patulous for the purpose.

"Moynihan reports a case in which a plastic operation was performed, removing for this purpose a flap from the stomach, which was left attached to its base, and used to fill the gap in the common duct. Studenrauch reports a successful operation of this character, and has devised a series of theoretical plastic operations for the purpose of repairing defects in the common duct, which are very ingenious, but have not been tried on a human subject."

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OPERATIONS UPON THE PANCREAS

CHAPTER V

OPERATIONS UPON THE PANCREAS

ANTHONY H. HARRIGAN

ACUTE PANCREATITIS

Indications.—Acute pancreatitis is a surgical disease. Medical treatment is of no avail, except in the interval preparatory to operation. Prompt diagnosis and early operation are imperative if a successful result is to be obtained.

Operation may be deferred with resulting serious delay by dawdling over vexing diagnostic problems. No one dominant symptom exists which expresses the presence or the stage of structural change in the pancreas. Acute pancreatitis possesses an essential tendency to simulate other various acute abdominal conditions which arise in the upper abdomen. Its clinical picture is somewhat similar to and often mistaken for acute intestinal obstruction of the duodenum or jejunum. This is a common diagnostic error and may occasion procrastination, while medical measures are used to overcome the supposititious obstruction.

Fortunately, the differential diagnostic possibilities are in the main conditions which may be properly subjected to surgical treatment. Hence, in the endeavor to establish the indications for operative intervention in acute pancreatitis, one is perplexed in formulating explicit directions. Any attempt to base the therapy of this disease upon a pathological classification is futile. A pre-operative differentiation of the various types—the suppurative, the hemorrhagic, and the gangrenous—is usually impracticable. Knowledge of the grade of the anatomic alteration should not affect the necessity and urgency of operation. Theoretically, mild cases of the hemorrhagic type, manifested by small subserous extravasations, might recover without operation. The absence of absolute diagnostic criteria renders this view purely speculative. As a matter of fact, the various changes of structural disintegration are commonly co-existent. The diagnosis of acute pancreatitis is usually sufficient and its elaboration generally *post incisionem.*

The discovery of fat necrosis in the omentum and abdomen is indubitable evidence of the existence of pancreatic disease. This sign is readily recognized and should lead

to thorough examination of the gland. The lesion is easily identified. The enlarged, swollen pancreas presents an absolute indication of its involvement. These 2 findings, the occurrence of fat necrosis and the glandular enlargement, are of vital importance.

A grave symptom, common and also characteristic of the disease, is marked collapse. The desirability of operation under these circumstances is a mooted question. Assuredly, operation should not be performed upon a moribund patient. But as collapse results from toxic absorption of the injured gland, no advantage is derived from a dilatory policy pursued with the vain hope that time will bring about its disappearance or even its amelioration. However, the judicious use of hypodermic stimulation is justifiable preceding the operative attack. But to prolong its employment is waste of time.

The extreme intestinal distention which frequently occurs in acute pancreatitis is not a contra-indication to celiotomy. However, its presence requires gentle and deliberative manipulation of the intestine in order to lessen the liability of additional shock.

Operative Technic.—The best incision is the median epigastric. This affords excellent exposure of the head and of the body of the organ. The tail is also accessible by this method, though its demonstration at times is not perfect. Therefore, in those cases requiring a more detailed investigation of the tail, a secondary working incision is permissible. This is preferably a longitudinal incision through the outer third of the left rectus muscle. A left Sprengel incision would suffice but it is time-consuming.

Following incision of the peritoneum, there usually occurs an escape of free fluid, brownish black in color, from the abdominal cavity. Large abdominal retractors are then adjusted, and wide separation of the wound margins obtained.

The stomach and transverse colon are now observed for the purpose of orientation. Palpation of the pancreas and determination of the extent and severity of the lesion are the next steps. These are best accomplished by lifting the transverse colon upward and outward and feeling the gland through the transverse mesocolon. Before attempting this, large laparotomy pads are arranged in order to keep the loops of the small intestine downward within the inferior abdomen.

After determining the extent and severity of the lesion, the pancreas must be rendered directly accessible. This is best done by division or tearing of the gastrocolic omentum. Provided that this method of approach is feasible, it is most desirable and should always be used. However, the extravasation may extend so far upward, or laterally in either direction, as to make the adoption of this route improper. That being the case, the gland may be reached by any of the following methods: By severing the duodenorenal ligament the second portion of the duodenum is mobilized and an approach attained to the head. Section of the gastrohepatic omentum is commended when the effusion passes upward into the lesser sac. In rare cases division of the ligamentum pancreaticolienale is necessary to expose the tail. Cutting of the transverse mesocolon is objectionable. Its section may wound the colica media artery and lead to gangrene of the transverse colon.

Upon exposure of the pancreas, a long, broad ligament clamp is inserted into the swollen and engorged parenchyma and the blades moderately separated. This will liberate the interlobular exudate and facilitate drainage. Any free clots of exudate are mopped or, better, aspirated away. The intra-abdominal part of the operation is then completed by inserting a large cigarette drain down to the pancreas. The drain passes between the stomach and the colon and projects some distance beyond the skin margin. Hollow rubber drainage tubes are objectionable and may lead to secondary hemorrhage from pressure or ulceration of an artery. A cigarette drain is preferable. Its main advantage is that the rubber protection prevents the formation of adhesions between the drain and the stomach and transverse colon.

Before closure of the abdominal wound the surgeon must inspect and ascertain the condition of the gall-bladder and the biliary passages. This is imperative in all pancreatic operations. Gall-stones (in the gall-bladder, common duct, and papilla of Vater) and duodenal ulcers are quite frequently associated with acute pancreatitis and, in a certain proportion of cases, have a direct etiological relationship.

The decision to operate upon a concomitant condition in the gall-bladder or bile-ducts calls for sound judgment. The operator must estimate the degree of surgical trauma inflicted during the pancreatic operation and consider whether the stage of shock or collapse will allow an additional operation. Again, the anesthetist must carefully weigh the peril of prolonged anesthesia.

If the conditions permit an attack upon the complication in the biliary passages, a large abdominal retractor introduced under the rigid margins of the wound and pulled upward and outward will expose the gall-bladder. The appropriate operation is then performed. Cholecystostomy, cholecystectomy, or choledochotomy may be required. If, on the other hand, it is evident that increased exploration and manipulation are contra-indicated, a rapid diagnostic investigation of the gall-bladder and biliary passages is legitimate, postponing active treatment until a secondary operation.

Closure of the abdominal wall is best done by the typical layer fashion, leaving a small vent for the exit of the drainage. If haste is demanded, through-and-through sutures of strong silk or silkworm-gut may be used. If, in place of hemorrhage, one finds glandular necrosis, the disintegrated parenchyma is sponged out, and the above-mentioned methods of drainage plus investigation of the biliary passages are instituted.

If suppuration is encountered, the technic is identical. However, additional caution in the arrangement of laparotomy pads and gauze packing is necessary to prevent undue contamination of the peritoneum. If the purulent collection is large and tends to point posteriorly, then one may have recourse to a supplementary incision in the left superior costovertebral angle. Occasionally both lumbar regions may be drained.

The abdominal route is vastly superior to the lumbar. It permits ready removal of peritoneal exudate and blood-clots. Free exposure of the pancreas is afforded, and the complicating conditions diagnosed and treated. The postoperative course following the lumbar incision is tedious. Pancreatic fistulæ and prolapse of the colon have been noted as its disadvantages.

Complications.—Severe secondary postoperative *hemorrhage* is fairly frequent. Its onset is usually early. Its source is generally from the arterial branches of the splenic artery imbedded in the superior border of the pancreas. At times the bleeding is concealed, the blood passing into the duodenum through a perforation and being manifested by melena or hematemesis. This dreaded complication may be expected only in the necrotic or gangrenous types of pancreatitis. Immediate intervention is demanded for effective treatment. The abdominal wound should be re-opened and a large amount of gauze packing firmly applied over the bleeding area. The usual symptomatic treatment for internal hemorrhage is followed out. It is impossible to isolate and ligate the individual bleeding vessels. Early operation is the best prophylaxis.

Thrombosis of the splenic veins with metastatic abscesses of the spleen is infrequent.

Subphrenic abscesses and empyema are seen in late neglected cases. These may be attacked in the usual manner, the former by the epigastric route or the transverse pleural incision and the latter by simple thoracotomy.

Mortality.—It is not correct to draw definite conclusions from the many scattered cases of various authors found in medical literature. Naturally, the favorable results of a large number of operations have been published rather than the unfavorable. Villar, who also mentions this difficulty, found 67 recoveries and 63 deaths. Körte, after considering Villar's statistics, reports finding, since 1905, the scattered records of 118 cases of operation for acute pancreatitis, with 73 recoveries and 45 deaths, a mortality of 38 per cent., but when he cut out from the list the cases that had been mentioned twice, he found that he had only 103 cases with 41 recoveries and 62 deaths, or 60 per cent. mortality. It is at once evident that these statistics are much less favorable and much nearer the truth than the first.

Additional statistics of Quénu, M. Robson, Ebner, Dreesman, and Nobe show that, out of 21, 59, 36, 118, and 43 cases respectively, there were 13, 36, 19, 61, and 21 deaths, or an average mortality of 55.2 per cent.

Körte reports 44 cases, 30 males and 14 females, in which the diagnosis was fully established. Only 38 of these cases were treated surgically; in 6 no attack was possible. Of the 38 cases operated upon, the diseased pancreas was directly attacked in 34, while in 4 of the patients merely the concomitant diseases of the gall passages received operative treatment. All of these 4 died. Of the 34 operated patients in whom, either as the result of a correct diagnosis arrived at during the operation or as the result of prior judgment, the diseased organ was immediately approached, 18 recovered and 16 died, a mortality of 47 per cent.

CHRONIC INTERSTITIAL PANCREATITIS

The operative treatment of chronic interstitial pancreatitis is logical in purpose and sound in principle. Complete anatomic restoration of the pancreas, or at least a welcome relief from distressing symptoms, may be attained. The non-operative treatment is usually inefficacious, the disease continuing unrelieved until death results from jaundice, cholangitis, hepatic suppuration, or diabetes.

The surgical treatment may be considered under two headings, according to the region involved:

A. Chronic pancreatitis of the tail and the body.

B. Chronic pancreatitis of the head.

A. CHRONIC PANCREATITIS OF THE TAIL AND THE BODY

Excision of the Sclerotic Portion.—When the disease is confined to the tail or to the body, excision of the sclerotic portion is the operation of election. This operation presents no peculiar difficulties, as the tail is relatively mobile and the peritoneal attachments with the contiguous viscera are few in number and thin in structure. During the dissection caution must be observed in isolating the splenic artery so as to avoid wounding or lacerating the arterial wall. The pancreaticæ parvæ branches are ligated individually. The margins of the divided pancreas are carefully co-apted to secure effective hemostasis and to prevent the escape of the pancreatic secretion into the retroperitoneal tissues. Drainage is employed.

The occurrence of sclerosis in this region is extremely uncommon. The chief clinical manifestation is the existence of a tumor in the epigastrium situated to the left of the median line. The discovery of this mass usually leads to surgical exploration.

Reyne's case is classical. This surgeon excised from the pancreas a segment measuring 8 cm. by 3 cm. The head and a small part of the tail were left undisturbed. Complete recovery followed. Occasionally, fragments have been removed during a gastrectomy or a cholecystectomy. These excisions have been made solely for pathologic and diagnostic purposes.

B. CHRONIC PANCREATITIS OF THE HEAD

Indications.—In the presence of this lesion 2 therapeutic possibilities exist. The first is to relieve the obstruction to the normal flow of bile into the duodenum and the second is to provide a means to lessen or to overcome the infection in the biliary passages.

By directing the operative procedures toward the consummation of these purposes, relief of distressing and dangerous symptoms is not the sole advantage achieved. A direct curative effect is produced, because the inciting cause of the inflammatory process is checked, for, from a practical point of view, chronic interstitial pancreatitis of the head is mainly due to infection or obstruction of the biliary passages. Hence, an operation undertaken primarily for its palliative effect may have a secondary curative action.

Even though complete extirpation of the head were anatomically and technically possible, the indication to establish drainage of the bile ducts would still remain. The conviction that the pancreatic sclerosis disappears after thoroughgoing biliary drainage is based upon the experience of many surgeons. The truth of the foregoing statement has been demonstrated beyond all doubt by secondary operations in numerous instances.

Chronic pancreatitis occurs more often in the head, owing to the intimate anatomical relationship of the common bile duct and the duodenum. As a secondary result, the sclerosis may cause compression of the common duct or perhaps a deviation or angulation in its course, resulting in jaundice and dilatation of the gall-bladder. Extension of the inflammatory process may occasion glycosuria, hepatic or pancreatic inflammation and thrombosis of the large veins, as the portal, splenic, or inferior vena cava.

An early operation is a decided advantage, for adhesions tend to form quite easily in this region. These adhesions rapidly become firm and resistant and ultimately unite the duodenum, pylorus, and gall-bladder into one conglomerate mass. The canal of Wirsung is subject to compression and cystic formation in the parenchyma is not unusual.

An exploratory celiotomy is indicated even when the general condition of the patient is poor. It should also be attempted when the differential diagnosis between chronic pancreatitis and carcinoma of the head is impossible.

The following methods of draining the biliary passages may be employed in chronic pancreatitis:

A. Cholecystenterostomy.
B. Cholecystostomy.
C. Hepaticus drainage with or without cholecystectomy.
D. Choledochus drainage with or without cholecystectomy.

(See also Surgery of the Liver and Biliary Passages, Chap. IV, Vol. IV.)

Cholecystenterostomy.—The purpose of this operation at first glance seems rational and logical. From the point of view of operative technic, however, 2 capital objections may be adduced to demonstrate its inutility. First, it is impossible to create a valvular anastomosis so as to prevent septic reflux from the intestine. Secondly, an inflammatory or friable condition of the walls of the gall-bladder renders secure suturing uncertain. Friability of the gall-bladder results, as a rule, from preëxistent cholelithiasis. When the gall-bladder is simply distended and no previous inflammation has existed, an anastomosis is safely and simply accomplished and the danger of leakage greatly lessened.

An anastomosis may be made with any accessible part of the intestine. When effected with the stomach, the term cholecystogastrostomy is employed. The operation is a makeshift and is wholly unphysiological. It contravenes the principles of all modern stomach operations which possess the fundament that the bile should be prevented from entering the stomach.

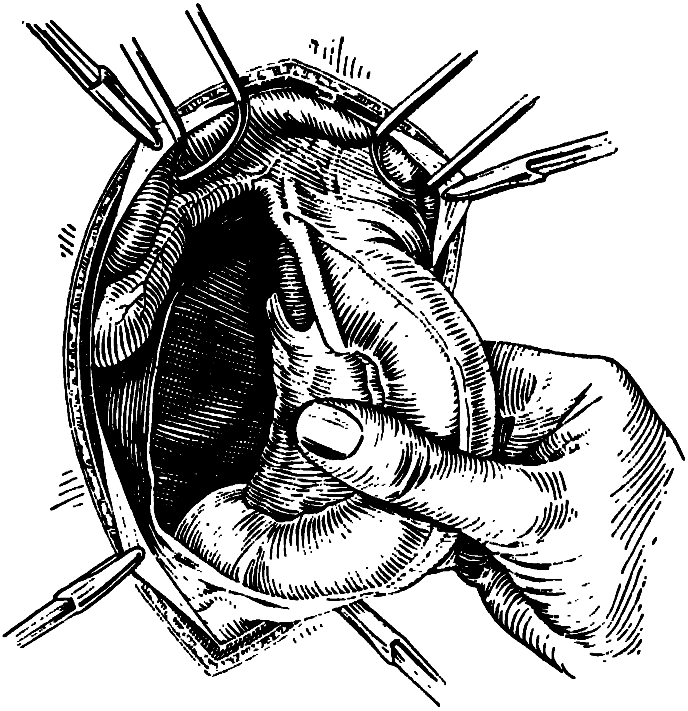

Fig. 1.—Exploration of the Head of the Pancreas and the Biliary Passages. (Desjardins.)

Cholecystoduodenostomy possesses a large number of adherents. The selection of the duodenum as the site of anastomosis is more physiological because the normal condition is closely approximated. The adoption of the hepatic flexure is inexpedient because of the higher virulence of the intestinal bacterial content at this level.

A summary of the objections to the performance of cholecystenterostomy is as follows:

(a) Friability of the gall-bladder entails the unlikeliness of effecting a safe and tight anastomosis.

(b) Retrojection of the septic contents of the duodenum or colon may induce suppurative cholangitis.

(c) Stricture or stenosis of the cystic duct or a partitioned condition of the gall-bladder render the operation valueless.

While the principle of the operation of cholecystenterostomy is sound from the mechanical point of view, the above-mentioned criticisms and technical disadvantages cause the operation to be chosen but exceptionally. As a matter of surgical interest, it may be mentioned that an anastomosis between the intestine and the common bile duct or even one between the hepatic ducts is possible.

Cholecystostomy.—This operation is comparatively easy of execution and its accomplishment can be effected more rapidly than the aforementioned procedure. Drainage is certain and free, provided the cystic duct is permeable and the gall-bladder not septated. One objection advanced is that the drainage passes through an accessory organ and not through the main biliary passages. The operation is safer than cholecystenterostomy and the results are excellent.

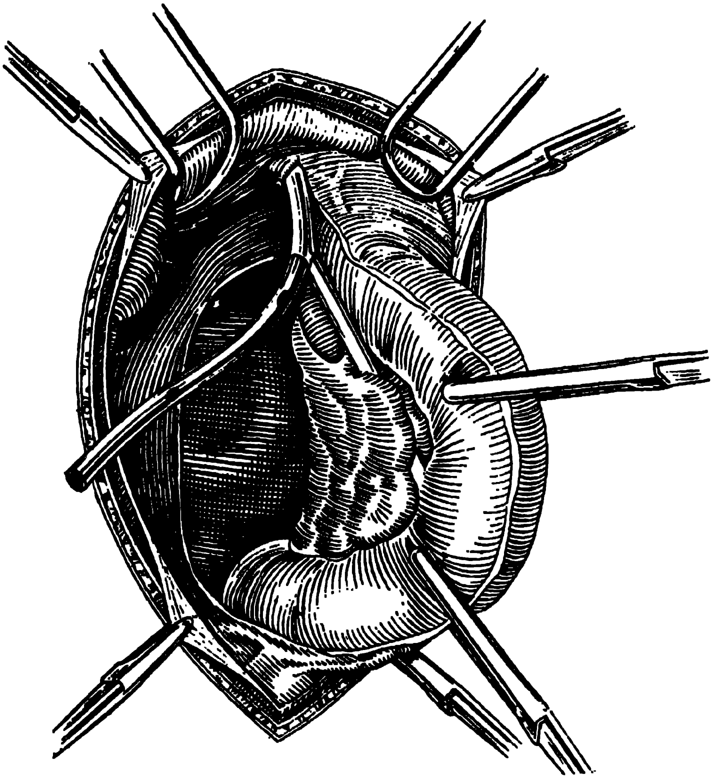

FIG. 2.—DRAINAGE OF THE COMMON BILE DUCT. (Desjardins.)

Drainage of the Common Bile Duct.—It is preferable to drain the common bile duct rather than the hepatic, because the caliber of the former is larger. Moreover, its greater accessibility and the fact that the drainage is established below the opening of the cystic duct constitute additional reasons. Choledochotomy is not a difficult operation. Its performance requires that the gall-bladder be normal, or if diseased, that the lesion be not permanent. When the gall-bladder is markedly diseased and functionless, cholecystectomy is the operation of choice. The latter procedure gives additional space for exploration of the common bile duct in order to establish drainage in the supraduodenal part of the duct. In case, however, there is a recurrence of the pancreatic inflammation and biliary drainage is again required, the absence of the gall-bladder constitutes a marked disadvantage, for without it the operations of cholecystostomy and cholecystenterostomy are naturally impossible. To meet this dilemma the common bile duct should be drained a second time.

This secondary drainage operation usually proves difficult. Owing to the presence of adhesions arising from the previous operative trauma the common duct is not easily isolated. The hemorrhage produced by the separation of the adhesions commonly floods the field and increases the technical difficulties. To surmount these obstacles, Desjardins proposes the following operation: An incision 15 to 20 cm. long is made through the outer third of the right rectus muscle. An endeavor is made to avoid the motor nerves. The intestines are held aside with laparotomy pads and the posterior parietal peritoneum along the external border of the duodenum is divided throughout its whole length. By lifting the duodenum to the left the head of the pancreas and the retroduodenal portion of the common bile duct can be seen and felt. A calculus in this part of the duct may be easily removed. By finding the terminal part of the common bile duct it can be traced upward, and the site of the previous drainage operation readily discovered.

(While I have occasionally used this operation in the past, I have ceased to do so. Adequate drainage is difficult.—EDITOR.)

Mortality.—Mayo-Robson reports a mortality of 3.9 per cent. in 102 cases of chronic interstitial pancreatitis. Among these were 56 cases of interstitial pancreatitis with gall-stones, 55 of which were cured by operation, and 46 without gall-stones, 45 of which were cured. In 2 cases diabetes ensued later.

Kehr reports an operative mortality of 11.6 per cent.

CONTUSIONS AND LACERATIONS OF THE PANCREAS

Indications.—Owing to its well-sheltered position within the superior abdomen, the pancreas is relatively infrequently injured. In contusions of the upper abdomen the adjacent viscera receive the maximum impact and tend to dissipate the violence. Therefore, injuries to the stomach, liver, spleen, and intestine are usually co-existent. Hence, the individual indications for operation in contusion and laceration of the pancreas cannot be stated categorically or succinctly, as the entire topic is closely interwoven with the general subject of subparietal wounds of the abdomen. In general, the special rules for surgical treatment of the latter are applicable to traumatisms of the pancreas.

Special knowledge of the nature and direction of the violence may aid in the diagnosis. For example, the pancreas, lying transversely in front of the vertebral column, is particularly exposed to crushing in run-over accidents and horse-kicks of the epigastrium.

Recognition of the direction of the striking or crushing force may assist in deciding the necessity for operation. For instance, a blow from within outward in the left hypochondrium may drive the spleen downward and outward and rupture the tail of the pancreas indirectly by traction on the ligamentum pancreaticolienale. Cadaver experiments demonstrate the feasibility of this type of injury.

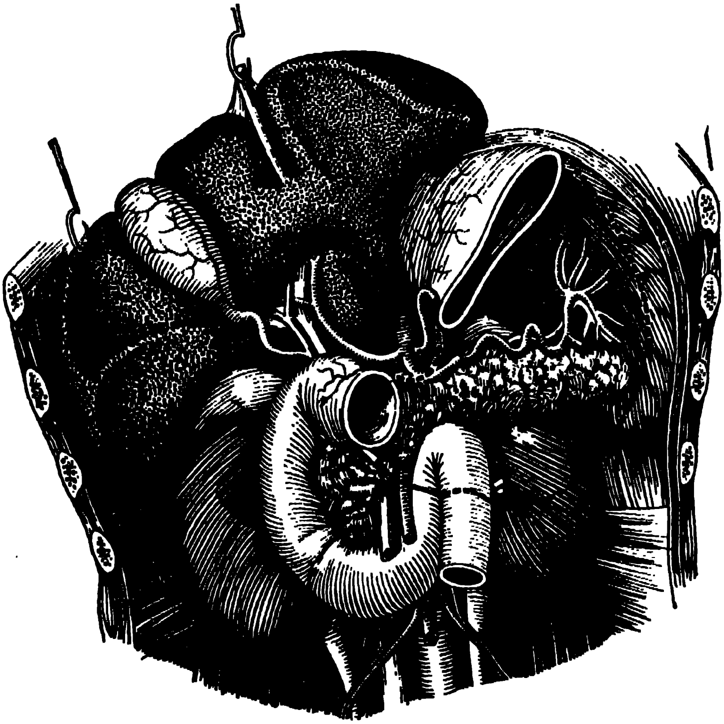

FIG. 3.—RELATIONS OF THE PANCREAS. (Testut.)

A suspicion of pancreatic injury warrants exploratory celiotomy. A positive diagnosis makes operation imperative. Profound shock contra-indicates, or at least suspends, operation until reaction has occurred.

Operative Technic.—The abdomen is prepared according to the predilection of the surgeon. As speed is essential in this type of injury, the iodin method is appropriate. Shock and collapse, which are usually present, are treated in the customary manner. Best reliance may be placed upon hypodermoclysis, rectal injection of coffee, and intravenous infusion of saline solution.

Vasomotor stimulants are administered to tone up the flagging medullary center. These measures may be carried on while the operation is in progress.

The abdomen is rapidly opened through a median epigastric incision. Technical requirements as to whether the incision should pass through the

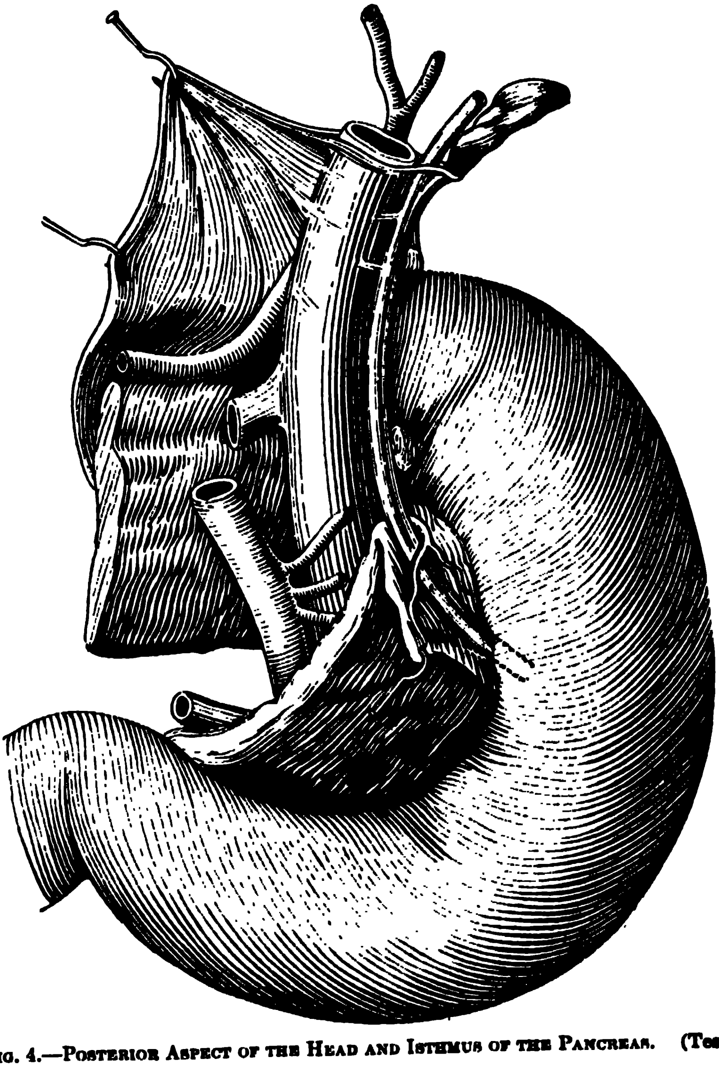

FIG. 4.—POSTERIOR ASPECT OF THE HEAD AND ISTHMUS OF THE PANCREAS. (Testut.)

linea alba or in a special portion of a rectus muscle may be disregarded as time-consuming. The transverse colon, which immediately appears in the center of the wound, is readily recognized by its omental attachment. It is lifted upward and the exploring hand follows the inferior surface of the transverse colon to the vertebral column. Upward pressure brings one in contact with the pancreas and marked disintegration of the organ is easily diagnosed. Less extensive tears or lacerations may not be discoverable with this technic. Hence, to verify the lesion, one may divide the gastrocolic omentum. This procedure furnishes excellent exposure of the body of the organ, the usual site of laceration.

A tear of the pancreas may be sutured provided the splenic artery is intact and unruptured, as the integrity of the arterial circulation through the pancreaticæ parvæ vessels is necessary to the vitality of the tail. Catgut should be used for suture. Interrupted sutures may be applied to the posterior and anterior surfaces. Anteriorly, they should include the anterior serous covering. Suture of the laceration may be difficult or even impossible, owing to the proximity of the portal vein and the superior mesenteric artery and vein. The friability of the pancreatic tissue is another disadvantage. No attempt should be made to find the duct of Wirsung, for it is usually ruptured and its suture is utterly impossible.

Resection of a separated portion of the gland may be accomplished when the detachment is complete or when the fragment is so crushed that necrosis is inevitable. This operation is especially applicable to the tail, though limited fragmentation of the head may permit resection in that region. Resection is performed by manual removal of the sequestrum. The ensuing hemorrhage is controlled by packing the void space with plain sterile gauze. The central stump of the organ may be ligated en masse or its margins approximated with mattress sutures. This checks the hemorrhage and lessens the liability of the escape of the pancreatic juice. The stump should be brought against the mesocolon if mobilization is practicable.

Tamponade with plain sterile gauze is always employed, even though suture or resection of the fragments be done. It affords drainage and furnishes the only certain method of stopping hemorrhage. In many cases it will be the only method permissible, resection and suture being used but exceptionally. They are impossible in any wound when excessive speed is a desideratum, or when the portal vein and mesenteric vessels would be endangered by excessive manipulation. The gauze must be nested securely. The ends are brought together through the abdominal incision. A long cigarette drain is an excellent adjuvant.

Following the special treatment of the pancreas the entire abdominal cavity should be thoroughly investigated for other visceral injuries, and if present, they should receive the appropriate treatment.

Before closing the abdomen any extravasated blood should be sucked out. Occasionally, if the hemorrhage has been excessive, one may pour hot saline solution into the abdomen and leave it there.

The abdominal wound should be closed up to the point of exit of the drain. Through-and-through suture may be utilized when the patient's condition is precarious.

Complications.—Fistulæ and cysts are frequent complications. They will be treated under separate headings.

Mortality.—Mikulicz estimates the mortality in the non-tamponed cases of wounds of the pancreas at 80 per cent.; in tamponed cases at only 38 per cent. Körte reports that out of 11 cases in 1907, 3 were cured by suture and tamponing. Guleke reports an operative mortality of 34.7 per cent. in 1910, mentioning the cases of 8 patients with isolated rupture of the pancreas who all died, partly because the operation was delayed and partly because the wound could not be located or was not properly cared for.

PANCREATIC CYSTS

Indications.—With the rapid progress and development in the methods and technic of abdominal surgery the operative treatment of pancreatic cysts became inevitable. During the pre-aseptic era the view was maintained—indeed, quite logically—that the remote situation of the pancreas and its close anatomical relationship to the large abdominal blood-vessels absolutely precluded any operation which necessitated celiotomy and manual manipulation of the cyst. At the present time, however, pancreatic cysts are definitely within the compass of operative surgery. The operation of extirpation forcibly illustrates the scope of surgery suggested. The main discussion centers around the character and degree of the contemplated operation.

The clinical recognition of a pancreatic cyst may be extremely difficult. Frequently operation will be undertaken for purely exploratory purposes, the true condition being determined after the abdomen is opened and inspected.

The diseases which are strikingly similar in their physical signs and symptomatology are the following: hydatid cyst of the liver, mesenteric cyst, and cysts arising from the ovary or kidney. Hartmann suggests that by placing the patient in the Trendelenburg position, the diagnosis is facilitated, as in that position an intra-abdominal cyst tends to return to the point of origin and attachment.

A timely operation makes for technical simplicity, thereby lessening its duration in a patient usually extremely emaciated and weakened. Inordinate delay is unreasonable and unwarranted for these cysts tend to contract strong adhesions to the stomach or colon which markedly increase the technical difficulties in either marsupialization or extirpation. In addition, a cyst may constrict the common bile duct, the compression of which consequently causes bile stasis with attendant degenerative changes in the liver. Again, the pressure may be exerted against a segment of the intestine and induce a partial or complete obstruction of the intestine. The continued pressure of a cyst can, moreover, produce an atrophy or fatty degeneration of the parenchyma of the pancreas. These anatomic changes may occasion profound changes in metabolism or evoke a severe and usually fatal type of glycosuria. An additional reason to support the advocacy of prompt operation is the tendency of pancreatic cysts to displace the large blood-vessels of the upper abdomen and to distort their normal anatomical relations. The superior mesenteric artery and vein, the portal vein and the splenic artery and vein are the blood-vessels usually affected. In fact, the splenic vein has been found coursing over the anterior convex surface of a cyst. An accidental division of a blood-vessel so displaced would cause a severe and unexpected hemorrhage. Such a contingency adds a grave risk to the operation.

Among the cysts characterized as sanguineous, which ordinarily result from an antecedent trauma to the abdomen, abrupt intracystic hemorrhage frequently occurs. Such an accident increases the seriousness of the condition and intensifies the urgency of operation, as the wall of this type of cyst consists solely of an attenuated layer of pancreatic tissue. The fear of this casualty should impel early operation, for timely intervention will prevent secondary infection from the intestinal tract, with resulting destruction of the cyst wall.

A pancreatic cyst during the course of its growth and development passes forward, as a rule, between the layers of the transverse colon and ultimately comes in contact with the anterior abdominal wall. Occasionally, one portion of the cyst projects upward into the lesser sac. As a result, the stomach is pushed upward while the colon is displaced into the lower abdomen or even into the pelvis behind the symphysis pubis. The jejunum and ileum are drawn to the lateral abdominal zones, while the duodenum insinuates itself around the lower margin of the cyst.

The clinical evolution is slow and gradual. The chief complaints are the volume and weight of the tumor. Ominous complications are hemorrhage within the cyst and intraperitoneal rupture.

Simple Puncture.—In the light of modern surgery this method of treatment is quite obsolete. Not only does the possibility of erroneous diagnosis preclude its use, but it is also rendered extremely hazardous by the danger of an intraperitoneal escape of the fluid contents. In addition, the likelihood of wounding large blood-vessels and the liability of perforation of the stomach or intestine would definitely contra-indicate the employment of this otherwise simple operation. It is barely possible, however, that an extreme contingency might impel its adoption in cases where special contra-indication to celiotomy existed, although such cases will be extremely rare.

Récamier's Method.—This method is described here solely for its historical interest. Récamier advocated successive applications of a powerful caustic (preferably caustic potash) to the abdominal wall, hoping thereby that adhesions would form between the parietal peritoneum and the serous covering of the cyst. When a sufficiently solid union was attained, a puncture or incision was made in the bottom of the cavity formed by the separation of the slough. Of course, the method is exceedingly crude and obsolete.

Marsupialization in Two Stages.—This operation was originally performed in a case of cyst of the kidney. Thiersch was the first surgeon to employ deliberately the method in the treatment of pancreatic cysts.

An incision is made over the most prominent portion of the cyst. Therefore, the incision may be placed in the linea alba, through the rectus muscle or parallel to either costal border. After division of the peritoneum the intestines are carefully held aside with laparotomy pads, the tumor is freely isolated, and a generous exposure of the convex surface of the cyst is obtained. If the cyst can be easily approximated to the anterior abdominal wall, the parietal peritoneum is sutured to the surface of the cyst for a variable extent, and the remainder of the abdominal wound sutured in the usual fashion. Four to 8 days later an incision or puncture is made in the extruded part of the cyst. The discharged contents are sponged away, and drainage established with a rubber tube or gauze. Before the insertion of the drainage, a digital exploration of the interior of the cyst is requisite, in order to determine the extent of the sac and to ascertain the pathological type of the cyst present.

If the cyst is deeply situated and the existing adhesions firm and comparatively old, then free mobilization of the cyst may be difficult, or even impossible. In that case, division of one or more of the serous coverings—the omentum, the gastrocolic ligament, or the transverse mesocolon—may be required to obtain complete isolation of the tumor. Occasionally, the various peritoneal layers may be intimately adherent in one homogeneous sheath so as to prevent the anatomical recognition of the layers. In addition, the cyst may be securely anchored to one or more of the adjacent viscera. This occurs particularly with the colon. The stomach usually escapes close or firm adhesions. These adhesions when found should be cautiously separated or divided to avoid laceration of the intestine. Any ragged edges of the intestine resulting from the separation of adhesions may be infolded with interrupted sutures of linen.

If the cyst is firmly fixed by adhesions, so that its delivery to the anterior abdominal wall is not feasible, Fenger and Nimier recommend draining the cyst through a posterior incision in the costovertebral angle. In that case, the abdominal incision is entirely closed and only lumbar drainage is used.

Marsupialization in One Stage, with or without Partial Resection of the Cyst Wall.—The primary steps of this operation are identical with those described above in the 2-stage operation. When the cyst is exposed, the contents are aspirated. This reduces the intracystic tension, aids free mobilization, prevents the escape of the contents into the peritoneal cavity and greatly facilitates suturing. If the wall of the cyst appears redundant, a segment may be excised. Any ensuing bleeding may be checked with a continuous catgut suture. As advised above, the inner wall of the cyst is investigated, a small rubber tube inserted, and the wound closed in part. A thick ointment is applied to the skin in the neighborhood of the wound to prevent excoriation and eczema.

The operation in 1 stage is vastly superior to that in 2 stages. Its principles are correct, and the procedure corresponds more generally to the modern ideas of abdominal surgery. The method permits of a pathological classification of the cyst; ascertainment of the limit and extent of the adhesion; a possible obstructing calculus may be removed or dislodged; and it affords an opportunity to decide the necessity or feasibility of complete extirpation. Marsupialization performed at 1 or even 2 stages implies certain risks and complications, notably prolonged suppuration, pancreatic fistulæ and ventral hernia. Theoretically, the operation is futile in the neoplastic cysts. It is best adapted and more suitable for the pseudocysts, which fortunately are more frequent.

Extirpation.—The profound situation of the pancreas, the intimate connection of the cyst with the gland, and especially the usual absence of a pedicle would seem to constitute fundamental objections to the radical removal of a pancreatic cyst. Despite these apparently insuperable difficulties, extirpation, from a surgical point of view, is the ideal and logical procedure, particularly in the case of neoplastic cysts. According to Delangénière, a pathological differentiation is possible at operation by palpation of the inner wall of the cyst. A nodular state indicates a new growth. Fibrous tissue indurations and calcified plaques closely simulate neoplastic formations.

The adhesions between the cyst and the transverse colon may be so extensive and firm as to prohibit extirpation. Prolonged manipulation in the upper abdominal zone is liable to induce operative shock, especially in an enfeebled patient. These 2 contingencies constitute the chief contra-indications to this radical operation. The technical difficulties may be extreme, owing to the displacement of the splenic vessels.

Extirpation is indicated in all pedunculated cysts or in those cysts in which a pedicle can be easily fashioned. Granted these conditions, it is positively indicated in all neoplastic cysts. Finally, in most cases where a success has been obtained, a partial resection of the pancreas has been added.

Mortality.—The mortality from total extirpation of pancreatic cysts is considerably higher than that from marsupialization and drainage, and extirpation is undoubtedly the far more dangerous method. Whereas Bessel Hagen, Wölfler and Körte place the mortality from marsupialization at 4.5 per cent., Goebell places the figure for total extirpation at 10.7 per cent. Guleke found in medical literature, in the last 10 years, 21 cases of total extirpation of pancreatic cysts with 2 deaths—9.5 per cent. This percentage, as compared with that of Tacayasu in 1898, of 15.3 per cent., may be considered at any rate as an improvement.

On the other hand, partial extirpation, as already shown, is considerably more dangerous, and naturally so, as those are usually cases in which the major operation is interrupted owing to insurmountable difficulties. Enough insistence cannot, therefore, be placed upon the avoidance of any hasty procedure in the way of operation.

PANCREATIC FISTULA

Indications.—A pancreatic fistula possesses a very feeble disposition to cease flowing, and consequently spontaneous closure is exceptional. The discharge is usually constant and persistent. The continuous secretion becomes the source of intolerable annoyance and keen distress to the patient, and operative relief is often imploringly requested. However, in view of the fact that incidental natural stoppage of the profuse flow occasionally takes place, and considering the magnitude of the curative surgical procedures, operation should be held in abeyance for a reasonable length of time. This waiting period has been established empirically as 9 months. During this interim various expedients (usually of a temporizing nature) may be used. Their chief value consists in allaying the anxiety of the patient.

Before initiating operative treatment for pancreatic fistula, other types of abdominal fistulæ must be absolutely excluded, such as those arising from the stomach, the intestines, the biliary and urinary tracts. A precise chemical examination of the secretion of the fistula for the pancreatic enzymes—trypsin, amylopsin and steapsin—will permit verification of its pancreatic source.

The preliminary procedures above mentioned consist in the minor surgical operations of cauterization, dilatation and curettage directed against the sinus or its orifice. In reality they are simple makeshifts. Cauterization of the sinus with silver nitrate or iodin is inefficacious. Slow dilatation of the sinus with laminaria tents is futile. Incision of the cutaneous orifice under local anesthesia plus rapid dilatation of the tract is extremely hazardous. Gentle curettage of the sinus has been advocated in addition to the preceding. These procedures are exceedingly dangerous, as peritoneal perforation may result. It is also risky to probe the sinus with the object of dislodging a possible obstructing stone.

Wohlgemuth's Treatment.—This method of treatment, which was introduced and highly praised by Wohlgemuth, is detailed at this point because its employment may prove serviceable and perhaps beneficial in the interval preceding surgical intervention.

The rationale of this procedure rests upon the recently revealed physiology of the pancreas. It is known that the pancreatic secretion is activated by a hormone called secretin, which is derived from the mucous membrane of the duodenum. The acid gastric chyme, as it enters the duodenum, evokes the formation and the liberation of secretin. Wohlgemuth believes that by reducing the degree of acidity of the chyme there occurs a reciprocal diminution in the intensity of the stimulus received by the duodenal mucosa, and in turn a reduction in amount of secretin formed and released. The reduction in the acidity of the chyme is accomplished by the administration of large doses of sodium bicarbonate and by a rigid adherence to a special diet. This diet consists essentially of proteins and fats, the use of carbohydrates being strictly prohibited. It is composed of meat, fish, eggs, butter, cream, milk, and cheese and only those vegetables which contain no starch or carbohydrates. Therefore, asparagus, spinach, and salad are included.

The régime should be followed religiously for at least 6 weeks. If at the end of that time there is no improvement in the fistula, the treatment may be abandoned. Though failures predominate, success has been achieved in some cases by this method. An analysis of the case reports demonstrates that it is more effectual for those fistulæ of traumatic origin than for those cases in which the fistula is consecutive to inflammation of the pancreas. It is probable that an infection alters the secretory mechanism. This procedure has a distinct field of usefulness as a measure to be employed in the post-operative treatment of all pancreatic operations.

MAJOR SURGICAL PROCEDURES

Excision of the Fistula.—When the pancreatic fistula is the result of a previous operation for a pancreatic cyst, secondary excision of the fistula and of the cyst wall has been urged as a curative measure. In one sense this operation seems reasonable, but analysis of its scope and object shows that it is a wholly illogical plan. It is clear that if the pancreatic cyst is irremovable at the primary operation, a secondary operation is of no avail. This conclusion is particularly strengthened when one recalls the great likelihood of the formation of extensive adhesions attendant upon the primary operation, that is—marsupialization. This view is confirmed by the experience of the surgeons (Polasson, Jaboulay and Gangolphe) who attempted this operation on 3 consecutive occasions upon the same patient. Each trial resulted in complete failure.

Operations to Divert the Fistulous Flow into the Alimentary Canal.—The principle underlying these operations is identical with that which is the basis of cholecyst- or hepato-enterostomy. This diversion of the pancreatic juice is accomplished by making an anastomosis between the sinus (or cyst wall) and some adjacent portion of the alimentary canal, preferably the stomach or duodenum. The terms pancreaticogastrostomy and pancreaticoduodenostomy have been formed to designate these operations.

PANCREATICODUODENOSTOMY.—This operation was first attempted by Weir in 1893. Following is an abstract report of the case:

M. Aged 35 years. Diagnosis, obstruction of the common bile duct. The incision was made in the right hypochondrium parallel to the costal border. The gall-bladder was aspirated and 150 to 200 gm. of bile removed. No calculi present. An urethral sound could not be passed through the common duct. The pancreas was greatly enlarged and a fluctuating mass was found at the level of the head. An incision into this mass revealed a cyst of the head of the pancreas. No communication could be determined between the cavity of the cyst and the duodenum. The cyst was packed with gauze. Cholecystostomy. Two days later a second operation was performed with the intention of doing a cholecystenterostomy and a pancreatico-(cysto)-enterostomy. After opening the abdomen, it was found that the cystic cavity had completely disappeared. Therefore, the idea of a pancreatico-enterostomy was abandoned. Cholecysto-enterostomy with a Murphy button. Death in 2 hours. Autopsy disclosed a carcinoma of the duodenal papilla.

Ombedanne has recently performed this operation with a technical success. A résumé of his case is given below:

F. Diagnosis, hydatid cyst of the liver. Kehr incision, which revealed a cyst of the head of the pancreas. Incision of the cyst. Vertical incision (5 cm.) of the duodenum. The duodenal and cystic margins were united with a continuous catgut suture, reinforced with a seroserous suture. Death on the seventh day from acute dilatation of the stomach. Autopsy disclosed a carcinoma of the ampulla of Vater. The anastomosis was permeable. No leakage.

It has been urged that this operation (Weir and Ombedanne) should not be attempted at the primary operation for a pancreatic cyst and supplant the older operation of marsupialization. The objections adduced by its critics are: (a) that cystoduodenostomy may produce a constriction or narrowing of the duodenum; (b) that the cyst may be so situated as to render an anastomosis impracticable. Ombedanne attempts to refute this criticism by suggesting that the duodenum is available for cysts located in the head of the pancreas, and the duodenojejunal flexure suitable for those of the tail of the pancreas. But this answer does not include the treatment of those cysts which pass upward and occupy the subhepatic or subdiaphragmatic spaces. Moreover, adhesions could prevent the mobilization of the cyst. (c) Infection of the cyst from retrojection of the duodenal contents. Theoretically this is possible as no sphincter is provided for in this operation.

PANCREATICOCHOLECYSTOSTOMY.—This operation has been successfully accomplished by Kehr. In a case with both biliary and pancreatic fistulæ, a cholecystenterostomy was done, and then the pancreatic fistula was implanted into the gall-bladder. The operation was wholly fatuitous. An anastomosis with the duodenum was impracticable on account of the presence of extensive adhesions. No details of the technic employed are offered in the case report.

PANCREATICOGASTROSTOMY.—This has been eminently successful in the hands of Doyen and Michaux. The latter, before incising the abdomen, introduced a probe into the sinus. The cutaneous orifice was then freely dissected and left attached to the intra-abdominal portion of the sinus. Celiotomy was then done and the sinus tract isolated. The presence of the probe within the sinus greatly facilitated this procedure. The cutaneous collar was then removed. The stomach was held with 2 clamps and a small incision made into the organ. The sinus was passed through the stomach incision and the line of contact sutured. The entire extragastric portion of the sinus was then imbedded in the gastric wall according to Witzel's method of performing gastrostomy.

Coffey's ingenious operation is described under the heading of pancreatic cysts.

TUMORS OF THE PANCREAS

The slow development of this topic has been due to the incompleteness in the knowledge of the biochemical and physiological processes of the gland, through the absence of a specific diagnostic test and in virtue of the technical difficulties attendant upon extirpation.

The operative surgery of tumors of the pancreas is, therefore, a relatively unexplored and still debatable field. Most operations have been performed with the vain hope that the suspected malignant tumor would be substituted by a benign and operable lesion. Generally, the presence of a massive growth with extensive hepatic metastases proved the futility of any surgical procedure. The clinical evolution of these tumors is slow and insidious, and a definite diagnosis is rarely made until the growth has metastasized and is inoperable.

A belief, however, in the reasonableness and utility of surgery in pancreatic tumors is strengthened by the possible perfection in the near future of the operative technic permitting a partial removal of the pancreas.

Classification.—Tumors of the pancreas may be classified as benign or malignant. The benign tumors are extremely rare, only 2 instances of successful removal being recorded. Shidler reports a case in which a tuberculous lymphoma was extirpated with a brilliant result. The second case is related by Körte, who removed a fibroma with splendid success.

Of the 2 kinds of malignant tumors, sarcoma and carcinoma. The former is uncommon, while the latter occurs with fair frequency. Twenty-eight cases of sarcoma of the pancreas have been reported, 4 of which were subjected to operation. The results were uniformly bad. In Malcolm's case the tumor had invaded the portal vein, and the patient died of shock at the conclusion of the operation. The patient whose case is described by Rossi died 5 months after operation from metastases. The 2 cases mentioned by Ehrlich were considered cysts at the time of operation, but a subsequent microscopic examination of the excised portions of the cystic wall proved them to be sarcomatous in character.

Carcinoma of the pancreas may develop either primarily or secondarily, the latter form being due to metastasis or proliferation of neoplasms from the neighboring organs, particularly the stomach. The head of the gland is the common site of the tumor, though the entire pancreas is often affected. A large tumor may invade adjacent organs forming adhesions, usually resulting in a variety of lesions from pressure. Although it has frequently been found necessary to close up the abdominal cavity in many cases in which the tumor was in an advanced stage and the patient's strength did not permit of a major operation, it is not wise in all cases to discard promptly every palliative procedure as useless.

Operative Technic.—The surgical treatment of tumors of the pancreas may be considered under two headings:

A. Pancreatectomy.

B. Palliative operations.

Pancreatectomy may be classified as partial or total according to whether a part or the whole of the pancreas is removed. It is an operation which is still in the nebulous state, chiefly because of the present imperfect knowledge of the physiology of the pancreas, and it has, therefore, become a fertile subject for the experimental surgeon. Aside from the important question as to the effect produced by total removal of the pancreas, the surgical research worker is mainly interested in the development of a technic intended to dispose of the remaining stump of the pancreas after a partial pancreatectomy.

Partial pancreatectomy is practiced fairly frequently as a supplementary procedure in operations on the pylorus, stomach, and spleen. It is employed here particularly when these organs are firmly attached to the gland or when a growth has invaded the parenchyma. For example, Montprofit resected a part of the pancreas during the removal of a large cyst of the broad ligament.

Partial pancreatectomy is applicable to tumors limited to the tail or the body and to certain rare cases of enucleated tumors of the head. The results of numerous operations show that excision of the tail, or even a part of the body, is wholly justifiable. The technical difficulties are not extreme, and the risks and dangers not excessive. Hence, if a tumor of the tail or body is found and the growth is limited, partial pancreatectomy is authorized.

Most of the operators have used the gastrocolic route to obtain access to the gland. A few have employed the mesocolic route. This proved fatal in Kroenlein's case. Here, the accidental division of the colica media artery caused gangrene of the transverse colon. Schidler divided the gastrohepatic omentum, while Ruggi endeavored to reach the pancreas by a retroperitoneal method, but without success.

Carcinoma of the head of the pancreas presents peculiar difficulties. Small limited tumors may be enucleated, but this, of course, presupposes that the ducts of Wirsung and Santorini have been uninjured. If the malignant process is diffuse and the entire head affected, operation had better be abandoned. The presence of important blood-vessels alone prohibits intervention on the head of the pancreas. For example, the operation would necessitate division of the gastroduodenalis artery, which would lead to gangrene of the duodenum.

Hence, to effect a successful removal of the head of the pancreas, it is necessary to add resection of the duodenum—in other words, to perform a pancreatoduodenectomy. This operation has been performed several times. The case of Michaux died of shock at the conclusion of the operation. Codivilla, in a notable case, performed this apparently bizarre operation. His patient died 20 days later from exhaustion.

Pancreatoduodenectomy exposes the portal vein, the inferior vena cava, and the superior mesenteric artery to injury. The operation entails the resection of the duodenum, division of the common bile-duct, and section of the ducts of Wirsung and Santorini. To restore the normal physiological connections, a supplementary cholecystenterostomy would be needed, and, moreover, an operation to repair the divided pancreatic ducts and to re-establish the normal flow of pancreatic juice. The operation exposes the patient to shock, hemorrhage, gangrene of the intestine, and suppression of the pancreatic secretion.

Sauvé and Desjardins, however, believe that this operation is justifiable and technically possible. These surgeons independently worked out the technic of the pancreatoduodenectomy. The researches of Desjardins slightly antedate those of Sauvé.

Desjardins proposed the following procedure: (a) A median epigastric incision is made. This is prolonged above by continuing it upward to the right costal border, while below it is lengthened by directing it downward and to the left. After generous exposure is obtained, the effort is made to liberate the duodenum. This is accomplished by a vertical incision parallel to and 2 cm. from the right border of the second portion of the duodenum. (b) Ligation of the pyloric and gastroduodenalis arteries and freeing of the extreme right edge of the great omentum are the next steps. (c) Division and ligation of the common bile-duct follow. Continue the mobilization of the duodenum and pancreas to the level of the superior mesenteric vessels. (d) Clamp the pancreas obliquely, avoiding the colica media artery. Clamp the duodenum at the proposed site of section, and excise the combined duodenum and head of the pancreas. (e) Close the pylorus with sutures, after introducing into the cavity of the stomach the male portion of a Murphy button. (f) Perform a gastrojejunostomy, but before doing this insert 2 small Boari buttons into the lumen of the jejunum. (g) Incise the jejunum and cause a small part of the Boari button to protrude and put this into the lumen of the common bile-duct. The anastomosis is effected with the aid of a ligature. (h) Apply a chain ligature to the pancreatic stump for hemostasis. (i) Isolate the canal of Wirsung for 2 to 3 cm. and effect an anastomosis with the jejunum in the same manner as with the choledochus. Drainage of the field of operation is the final step.

Desjardins says that this manner of disposal of the bile duct and the canal of Wirsung is possible only when the canal of Wirsung is dilated. If the operation is not feasible because of the contracted condition of the pancreatic duct, one must implant the pancreatic duct into an excluded loop of jejunum, which in turn is anastomosed with the efferent loop of the gastrojejunostomy. Moreover, if the length and complexity of the operation seem to contra-indicate the complete procedure at 1 step, the 2-stage operation may be employed. At the primary operation perform the gastrojejunostomy, and at a later date remove the tumor and effect the biliary and pancreatic anastomoses.

Sauvé proposes the following technic: (a) Celiotomy and exposure of the operative field by a long median epigastric incision. (b) Ligation of the pyloric and gastroduodenalis arteries. Section of the pylorus with immediate closure by the suture method. (c) Incise the parietal peritoneum to the right of the second portion of the duodenum and mobilize it with the associated head of the pancreas by blunt dissection. The retropancreatic separation is important and must be carefully carried out. (d) Divide the third part of the duodenum after taking note of the position of the superior mesenteric arteries. (e) Separate the so-called "little head" of the pancreas from the superior mesenteric vessels. Also, separate the portal vein from the head of the pancreas. (f) Ligate the gastroduodenalis artery and then remove the divided duodenum plus the head of the pancreas, which is clamped. Divide and ligate the common bile-duct.

These extensive procedures are supplemented by a gastrojejunostomy and choledo-enterostomy, while the pancreatic stump is brought to the level of the skin margins. Sauvé, following Desjardins, advises the employment of the 2-stage principle.

A study of the technic of these 2 procedures shows that the vital point of difference lies in the method of treating the stump of the pancreas. Herein lies the crux of the entire subject. Körte would solve the difficulty by the removal of the entire gland. This, of course, would aid in lessening the liability of recurrence, for in the complete operation an extensive removal of the gland would be entailed. Franke reported a case of successful removal of the entire gland in which a transitory glycosuria occurred. From the views advanced by physiologists, it would appear that pancreatectomy is a fatal operation in dogs. This was the opinion maintained by Minkowski and von Mehring, the pioneer workers in this subject. Recent experimental work by Pawlow, Martinotti, and Cecherelli, however, seems to demonstrate that this is not always the case. Moreover, caution must be observed in transferring the results of animal experimentation to man.

As stated above, the disposal of the pancreatic stump has been the subject of numerous studies. As a result of these, we know that when a wound of the pancreas is covered with peritoneum, the tendency toward adhesion formation is as strong as in the omentum.

Sulite believes that the method of treatment for the pancreatic stump advocated by Desjardins and Sauvé is impracticable because of the possibility of necrosis and infection. Sauvé conducted investigations as to the fate of the stump left within the intestine. He found that the extra-intestinal portion underwent acute inflammation and necrosis. Hence, he advised implantation of the skin; but this leads to an intractable eczema.

The studies of Coffey, whose work is a natural sequence to that of Sauvé and Desjardins, are perhaps the most brilliant of all. His earlier work concerned pancreatectomy while his later work was confined to pancreato-enterostomy. As a result of his vast experimental work on dogs, Coffey would advise the following steps for performing pancreatectomy in the human: First: Removal of the head of the pancreas, bearing in mind the 3 dangers mentioned by Sauvé—injury to the portal vein; injury to the superior mesenteric vessels, which is followed by gangrene of the small intestine; and injury to the right colic artery, which is followed by gangrene of a part of the colon. Removal of the head of the duodenum and pancreas is carried out as follows: (a) A median incision from the ensiform to below the umbilicus. (b) Ligation of the pyloric artery and of the gastroduodenal artery. (c) Section of the pylorus or duodenum just below the pylorus. (d) Division of the fascia along the right border of the duodenum. (e) Posterior dissection of the second portion of the duodenum and the head of the pancreas. (f) Section of the duodenum at a point sufficiently far from the superior mesenteric vessels to protect them from injury. The dissection of the duodenum should be carried to a point at which it can be easily separated from the head of the pancreas, but not to the mesenteric vessels. (g) Ligation below of the pancreatoduodenal vessels. (h) Section of the duodenum and suture of its lower end. (i) Separation of the "lesser" pancreas from the mesenteric vessels which cross in front of this portion. (j) Separation of the pancreas from the portal vein. (k) Section of the head of the pancreas. (l) Ligation and division of the common bile-duct, division of the gastroduodenal artery, and removal of the portions of the duodenum and pancreas. The cut end of the bile duct and the cut end of the stomach or duodenum, as the case may be, are then held in clamps, and the cut end of the pancreas wrapped in gauze awaiting implantation into the loop of jejunum.

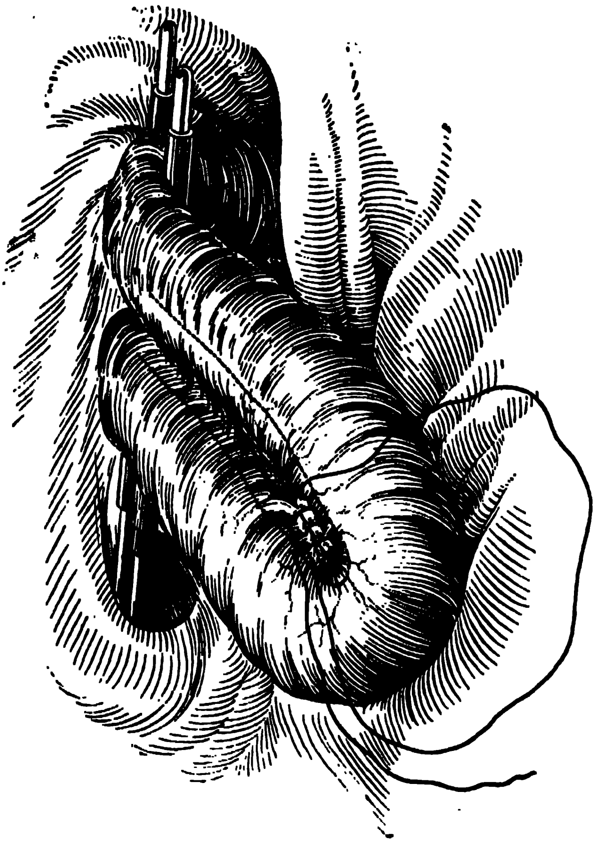

FIG. 5.—PANCREATO-ENTEROSTOMY. Suturing arms of intestinal loop together with primary Lembert suture. (Coffey.)

Second: If the gastrocolic omentum has not already been severed to permit a good exposure for work, this may now be done. An opening is made through the transverse mesocolon near its root, through which a loop of jejunum 1 or 2 ft. in length is drawn. The pancreas is now implanted into the upper portion of this intestine, the stomach or duodenum is anastomosed lower down, and the common bile duct implanted still lower down. A few interrupted linen sutures fasten the intestine to the mesocolon as it passes up and down through the slit. These sutures also close the opening and prevent hernia.

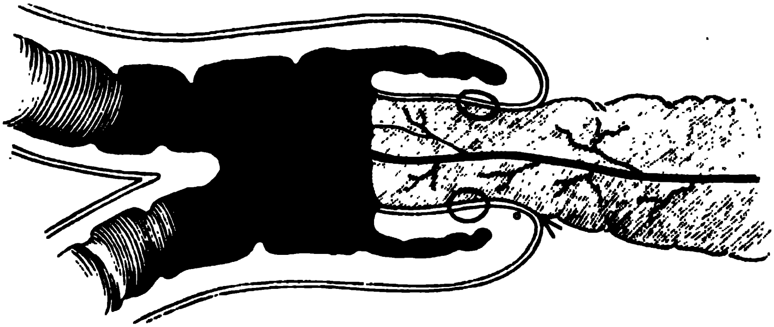

FIG. 6.—PANCREATO-ENTEROSTOMY. Sectional view of pancreato-enterostomy. (Coffey.)

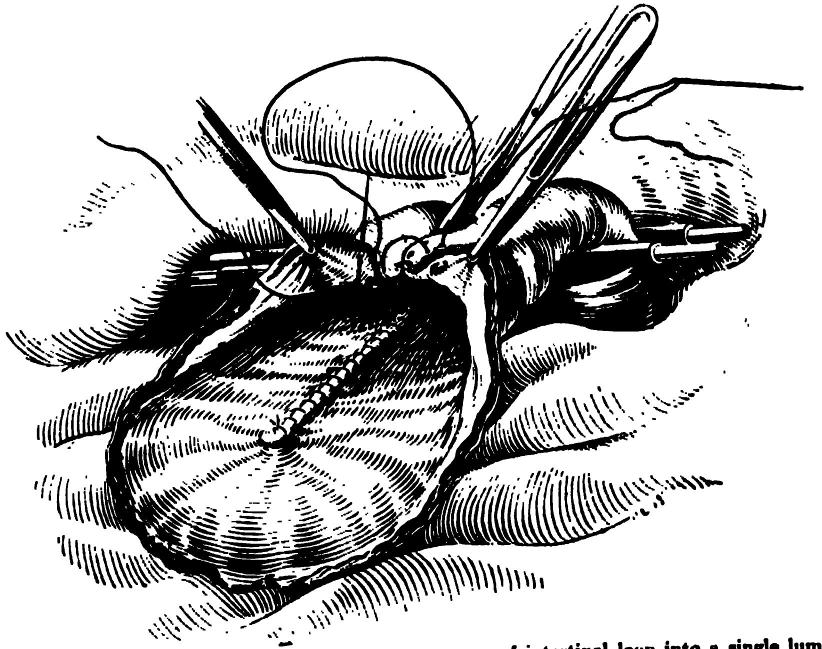

FIG. 7.—PANCREATO-ENTEROSTOMY. Converting two arms of intestinal loop into a single lumen by continuation of through-and-through suture. (Coffey.)

Coffey advises the following technic for pancreato-enterostomy without pancreatectomy in the human: (a) Divide the gastrocolic omentum and loosen the tail of the pancreas by dissection and ligation of the vessels. (b) Pick up a loop of jejunum as near to the ligament of Treitz as possible, and yet long enough to reach the tail of the pancreas with ease. (c) Perform entero-enterostomy between the links of the loops. (d) Make a hole through the mesocolon well to the left of the ligament and draw the loop of intestine through the opening. (e) Strip and cut the duct of the tail of the pancreas and plant it into the loop. Fasten the intestine to the mesocolon where it passes in and down through the opening. (f) Repair gastrocolic omentum.

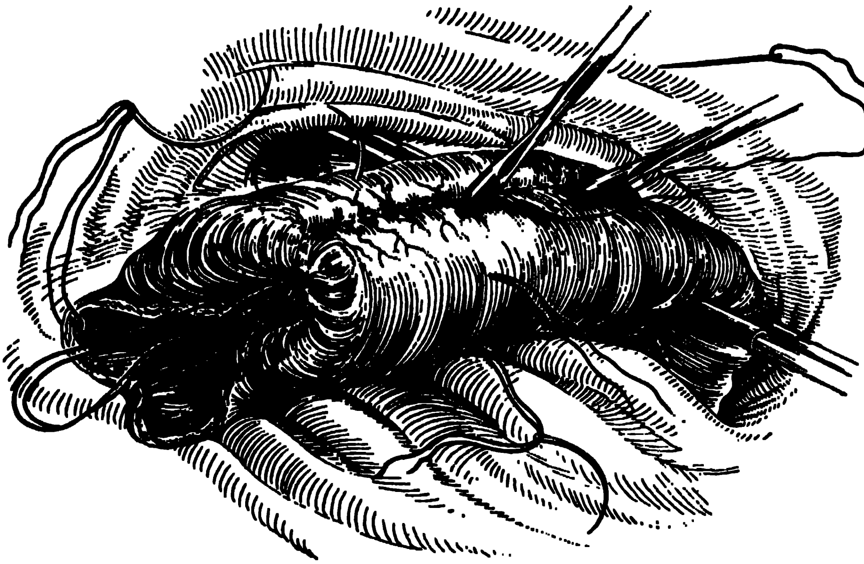

FIG. 8.—PANCREATO-ENTEROSTOMY. Passing intestinal traction sutures into the lumen and out through the wall of the intestine. (Coffey.)

According to Coffey, his operation is comparable to a cholecystenterostomy. For example, when the pancreatic secretion cannot enter the head because of an obstruction in the head, the tail must be united to the intestine, as it has been demonstrated that the pancreatic secretion flows easily in either direction. Coffey believes that in the future the operation will be as important and as frequently performed as gastrojejunostomy. For anatomical reasons, the operation is much easier to perform in dogs.

Von Faykis, one of the most recent experimenters, thinks that Coffey's procedure is safe and sound, but that it is not practicable in surgery, as it would unduly prolong an operation. As a result of his researches, v. Faykis recommends lateral implantation, maintaining that narrowing of the intestine does not occur. Moreover, this objection is theoretical, as a gastrojejunostomy is almost always performed. In case this is not done, stenosis is not likely to occur when the stump is not pushed too far. A study of the specimens shows that the internal projecting part disappears with a resulting cicatrix.

Kausch reports that he is not satisfied with the results of cholecystenterostomy, although an entero-anastomosis was always performed in addition. He lost several patients through cholangitis. Kausch, therefore, advises the performance of cholecystogastrostomy or duodenostomy, the former being especially recommended by Hildebrand. But not in every case will it be possible to avoid cholecystenterostomy. Under such conditions Kausch proceeds in the following way: An entero-anastomosis is performed; the side piece of the intestine which leads away from that point is cut through close to it and both ends closed. The longer one is connected with the gall-bladder and this part of the intestine changed into a narrow canal by continuous suture of the serosa. Kausch always performs hepatocholangi-enterostomy or hepato-enterostomy in 2 intervals, hepatostomy first. His reasons are: (a) if the operation is not divided into 2 parts, the strain is too great; (b) it is more difficult to stop hemorrhage; (c) one never knows whether, after the relief of the liver, the physiological passage will not become free and the major operation be thus rendered unnecessary. It is best to enter the liver from the gall-bladder, and afterward to connect the latter with the intestine.

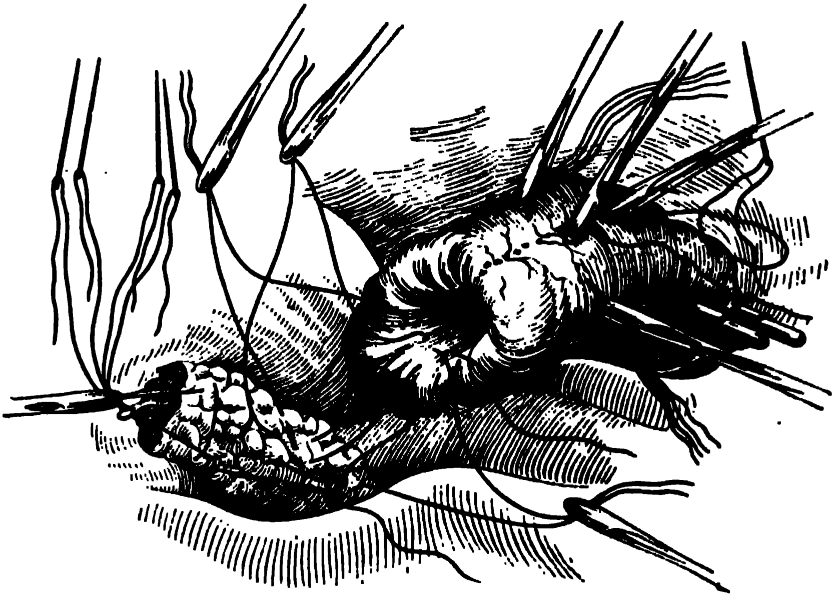

FIG. 9.—PANCREATO-ENTEROSTOMY. Preparing to introduce cut end of pancreas into lumen of inverted gut. (Coffey.)

The formation of a new biliary duct may sometimes become necessary, and Kausch advises the formation of the new biliary duct out of the intestinal wall by plastic operation.

It is comparatively easy to extirpate the tail of the pancreas, yet more difficult to do so with the central portion. The removal of the head of the pancreas involves the greatest difficulty, particularly because of the connection of the rest of the pancreas with the intestine. Simple implantation of the duct is unsafe because the broad surface of the incised pancreas is secreting. In 1 case of papillary carcinoma, Kausch removed the head of the pancreas and turned the transversely bisected duodenum over the incised surface of the pancreas. Nine months after the operation the patient died from cholangitis. Post-mortem examination showed that the intestinal communication with the pancreas was working excellently; no metastases were present.

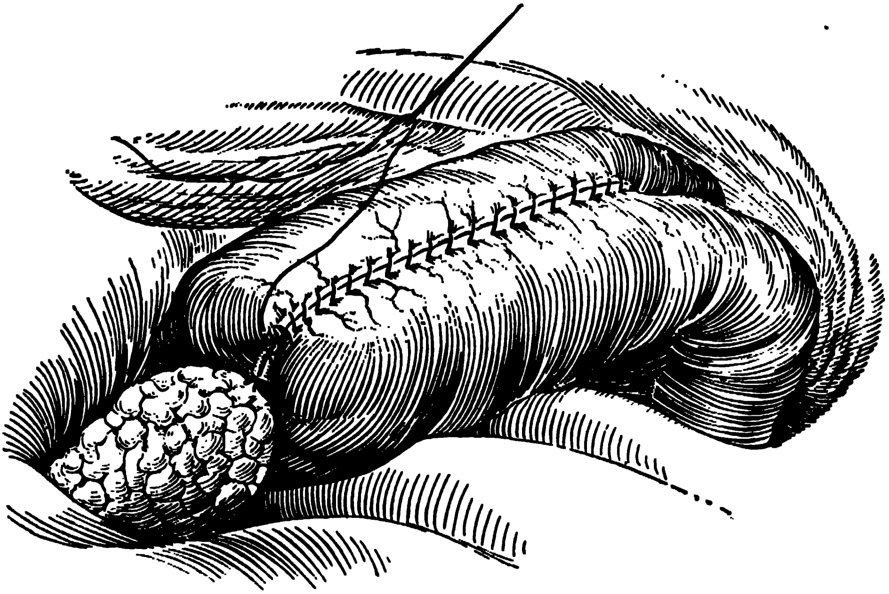

FIG. 10.—PANCREATO-ENTEROSTOMY. Complete operation with primary suture. (Coffey.)

Mortality.—Owing to the loss of the juices which it occasions, cholecystostomy has proved very unsatisfactory, the majority of the patients surviving but a few weeks at most. For this reason Riedel, Körte, Villar, and Robson have practically abandoned its use. Better results are reported from cholecystenterostomy, 6 to 8 months being the usual survival period.

Guleke, in 24 collected cases of extirpation of the pancreas, reports an operative mortality of 50 per cent. Those cases which survived operation lived 5 months at the most, all of the patients eventually dying from recurrence or metastases. The results, therefore, are not brilliantly successful, but it would be wrong to conclude that, in proportion to the risk to which the patient is exposed, there may not be a considerable gain. On the other hand, they would rather seem to indicate the urgent necessity of timely operation.

The cases cited at least prove that extirpation of the pancreas is technically feasible and may be survived.

Kehr reports 71 cases of patients with pancreatic carcinoma upon whom he performed palliative operations. Of this number 10 lived considerably improved for 2 years, which would seem to demonstrate the value of such procedures in selected cases.

SURGERY OF THE SPLEEN

CHAPTER VI

SURGERY OF THE SPLEEN

RUSSELL S. FOWLER

SURGICAL ANATOMY

(Modified from A. B. Johnson's Adaptation from Merkel)

The normal spleen is a soft, elastic, rather fragile organ of tetrahedron shape, conforming to the surrounding viscera, its base directed toward the diaphragm, its apex downward. The general contour of the spleen is concavo-convex. There are 4 surfaces, diaphragmatic, gastric, renal, and basal. The diaphragmatic surface, the largest, lies beneath the ninth, tenth, and eleventh ribs. The longest diameter corresponds very nearly with the direction of the tenth rib. Behind the diaphragm and between it and the chest wall the pleura extends below every portion of the spleen. The lung reaches posteriorly to the level of the eleventh dorsal vertebra, so that the spleen is also partly covered by lung. The gastric surface is in contact with and moulded upon the posterior surface of the fundus of the stomach, this contact obtaining only when the stomach is full. The renal surface is in contact with the outer border of the upper pole of the left kidney, the extent of surface varying with the position of that organ. The basal surface, the smallest, is in contact with the tail of the pancreas and the splenic flexure of the colon.

The spleen extends toward the middle line nearly or quite to the border of the eleventh dorsal vertebra. Laterally the lower part of the spleen extends as far forward as the midaxillary line, but normally not beyond a line drawn from the left sternoclavicular joint to the tip of the eleventh rib. The anterior border is somewhat sharp and has one or more indentations, usually a single notch. The spleen moves with the diaphragm with respiration, but less so than the liver. The condition of fullness or emptiness of the stomach and colon respectively has some effect upon the position of the spleen. If an individual lies upon the right side of the body, the upper and anterior border of the spleen moves downward and forward a distance of 3 to 4 cm. farther than when the subject stands erect or lies on his back. The spleen cannot be palpated when normal, nor can its limits be made out accurately, by percussion, except its lower and outer end. The area of splenic dullness may be abolished in emphysema or covered by pleuritic effusions. Tumors of the spleen may displace the diaphragm upward. This is more apt to occur in children than in adults, because in the former the phrenocolic ligament affords firmer support, holding the spleen firmly against the diaphragm.

The spleen in the adult is, on the average, about 5 in. in length, 3 in. in breadth, and 1¼ in. in thickness. The weight of the spleen in the cadaver is from 150 to 200 gms., and a sixth more when filled with blood. Its size varies under different conditions more than any other organ in the body. It is larger in proportion in children, increases in size after eating, and becomes regularly enlarged in a variety of diseases. It may become so large that it reaches to the pelvis and fills the abdomen.

The spleen is held in place by folds of peritoneum containing firm bands of fibrous tissue. Such a fold passes from the left crus of the diaphragm to the spleen. The suspensory ligament, *phrenosplenic ligament,* and the *phrenocolic ligament, sustenaculum lienis;* the latter, passing from the diaphragm to the splenic flexure of the colon, supports the colon, and, since the spleen rests upon the colon, supports it also, forming a kind of pocket for its reception. The gastrosplenic omentum, necessarily a loose connection, on account of the movements of the stomach, has but little influence in the fixation of the spleen. The ligaments of the spleen may become relaxed, permitting the spleen to fall down and hang free in the abdomen, supported by its vessels. The spleen is surrounded by a firm connective-tissue capsule, which sends connective-tissue septa into the interior of the organ, affording support to the soft and friable parenchyma.

Blood Supply.—The spleen receives for its size a very large supply of blood. The splenic artery runs a tortuous course, from right to left, and divides, before reaching the organ, into from 6 to 12 branches. These vessels enter the hilum of the spleen, but do not anastomose in its substance. The splenic vein runs parallel with the artery, is double its size, lies below it, and empties into the portal vein.

Anomalies.--L. Brown records a case in which there was no pedicle as such, 4 very large distinct arteries taking the place of the pedicle. Small collections of splenic tissue are occasionally found in the splenic pedicle, in the great omentum, in the transverse mesocolon, and at times in the tail of the pancreas. If not diseased, they are left undisturbed.

SPLENECTOMY

History.—Greig Smith gives an interesting account of the history of this operation. The operation is of some antiquity. Among the ancients it was performed supposedly to improve the wind of the individual. Pliny (A. D. 23-79) makes the observation that "sometimes it is a peculiar hindrance to runners, so that they burn it away from those runners who are incommoded by it." In 1581 Viard removed a spleen prolapsed through a wound. Dionis speaks of a sect of surgeons which acquired notoriety about 1700 by their operations for removing the spleen. For prolapse of the spleen through a parietal wound, splenectomy was done by Matthias in 1678. For disease, the first operation, according to Collier, was performed successfully by Zaccarelli in 1549. The second operation, by Ferrerius in 1711, seems to have been the removal of a rudimentary spleen from an abscess; it was also successful. Both these operations have been discredited. Quittenbaum, in 1826, and Küchler, in 1855, each removed an enlarged spleen, each case dying in a few hours of hemorrhage. Spencer Wells removed a hypertrophic spleen in 1865, the patient dying in 6 days of either thrombosis or sepsis. Péan, in 1867, successfully removed a cystic spleen.

Indications.—Splenectomy is indicated in certain cases of *splenomegaly accompanied by hemolytic anemia and acholuric jaundice* (Bland-Sutton); in *Banti's disease* (splenic anemia) prior to the stage of hepatic cirrhosis, i. e. before the liver has become hopelessly involved; in certain cases of *hematemesis due to engorgement of the gastric and esophageal veins consequent to obstruction in the splenic vein* (Bland-Sutton); possibly in certain cases of *splenomegaly secondary to obstruction of the portal vein* (Bland-Sutton); in *aneurysm of the splenic artery* (Winckler); in *injuries;* and in *traumatic hernia* of the spleen.

In *movable* (*ectopic*) *spleen*, splenopexy has been effectual in some cases in retaining the spleen in position, but the symptoms have persisted and splenectomy has been usually required eventually. It is the operation of choice if the ectopic spleen has occasioned symptoms. Moderate mobility of a normal sized spleen without symptoms is not an indication for splenectomy. Extensive mobility, however, with its consequent danger of torsion of the pedicle is a distinct indication.

Splenectomy is also called for in *twists of the pedicle,* in *tumors,* malignant and benign, and in *cysts.* Dermoid cysts are extremely rare; echinococcus cysts are rarely met with. Where splenectomy is impossible on account of adhesions, those operations which have proved efficacious in echinococcus cyst of the liver under similar circumstances are indicated, i. e. excision, resection, marsupialization. In non-parasitic cysts, splenectomy is done where possible; otherwise excision of the cyst.

Removal of the spleen may be indicated in *Egyptian splenomegaly.*[1] In selecting cases for operation, the size of the spleen is of relatively little importance. Richards believes that the determining cause of death in these cases is not the splenomegaly or anemia but the cirrhosis; therefore, the condition of the liver is the one essential factor. Early cases seldom apply for relief and in any event, if mild, should always be allowed the chance of spontaneous recovery. Operation is contra-indicated in advanced cases with ascites and emaciation. Richards very aptly remarks that removal of the spleen cannot cure a cirrhosis that is so far advanced as to be visibly killing the patient, while the shock of the operation and the anesthetic are only too likely to hasten the end. Treating the ascites by a Talma or similar operation or by Patterson's button is uniformly unsuccessful. These cases can be relieved by repeated tappings, and in some the ascites diminishes or disappears; this improvement is but temporary and, as a rule, death ensues in about 6 months (Day). Summed up, indications for operation in these cases are enlarged spleens and livers in cases in which the disease is severe and progressive, but which have not yet reached the ascitic stage.

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[1] In Egypt a disease with a clinical and pathological aspect similar to Banti's disease is of frequent occurrence. It has been described by Day and Ferguson under the title of "Endemic Splenomegaly with Cirrhosis" and subsequently by Richards and Day under the name of "Egyptian splenomegaly." It presents certain marked differences from many of the cases which have been classed with Banti's disease. It pursues a definite and uniform course.

Splenectomy is indicated also *when the spleen is intimately adherent to tumors whose removal is indicated;* in *splenomegaly* (Gaucher type); in *spontaneous rupture,* idiopathic, malarial, and typhoid; possibly in certain cases of pernicious anemia associated with chronic splenitis; in certain cases of *hypertrophied spleen;* and in *idiopathic hypertrophy* on account of the danger of rupture from even slight injury or because of discomfort from size and pressure on other organs, or by reason of twists of the pedicle. Simple hypertrophy without complication is not an indication. In *malarial hypertrophy* operation is indicated in those cases which have a twisted pedicle. Aside from this the general indications are the large size of the organ, with pain and dragging and the danger of trauma, the mobility, with consequent tendency to rupture and the possibility of acute torsion of the pedicle. Spontaneous rupture is not infrequent in the tropics. Jonnesco has pointed out that splenectomy having for its aim the cure of the malarial condition is not founded on sound reasoning and should not be an indication. Persistent anemia is given as an indication by some. Occasionally *abscess* is an indication. Splenectomy is indicated in *recurring abscess* of the spleen and as a primary operation in those cases in which adhesions are slight. Splenotomy is the operation of choice if adhesions are firm. In the majority of cases adhesions are extensive and splenectomy is impossible. Splenectomy has been occasionally done in *tuberculous splenomegaly* either because of a complicating rupture or with the intent of improving the constitutional symptoms.

Contra-indications.—Splenectomy is contra-indicated in erythemia (Vaquez's disease); in leukemia; in diseases in which the spleen is involved secondarily, except as stated in the paragraph upon indications; when adhesions are extensive; in such general diseases as tuberculosis and syphilis; and in the usual general conditions contra-indicating a major surgical procedure.

Instruments Required.—The usual instruments for making and closing a laparotomy incision are required. Special instruments required are a broad

retractor for retracting the lower ribs; a costotome, in case Auvray's incision is used or it becomes necessary to resect the ribs; long ligatures on needles for controlling bleeding from adhesions in the vault of the diaphragm; 2 gastro-enterostomy clamps guarded by rubber tubing; mosquito forceps, several large gauze packs ready for quick use; and a strong scalpel for cutting across the rib cartilages.

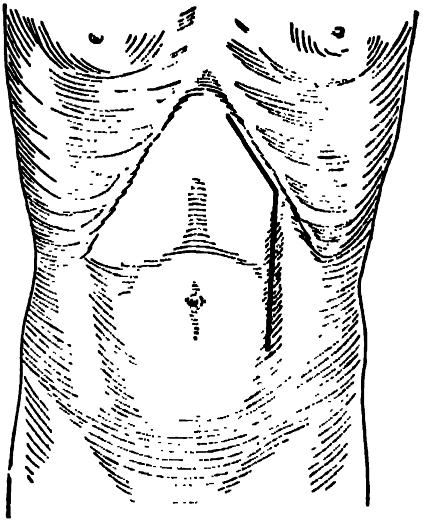

Fig. 1.—Mayo's Incision for Splenectomy.

Incision.—The incision of choice is made along the outer border of the left rectus muscle from the costal arch downward, the length of the incision depending upon the size of the spleen to be removed. If more room for manipulation is needed the incision may be extended at its upper end parallel with the costal border toward the middle line (Mayo) (Fig. 1), or Auvray's incision may be employed. Auvray's incision is particularly indicated in difficult cases. The primary incision is made in the usual manner along the outer border of the left rectus muscle. Exploration having shown the case to be a difficult one requiring more room, the upper end of the incision is extended upward and posteriorly over the lower ribs at the level of the eighth interspace (Fig. 2). The flap of soft parts is dissected outward so as to expose the eighth, ninth, and tenth ribs (Fig. 3). This cartilaginous segment is now excised by dividing the cartilages close to their anterior extremities and freeing the segment from before backward and from below upward, keeping close to the ribs during the dissection. Finally the excision is completed by separation of the segment a little anterior to the costochondral juncture. A broad retractor is used to raise the remains of the thoracic border. This, together with the retraction of the soft parts, gives a good exposure of the entire spleen, and by manipulation every portion can be examined. I have used this incision with satisfaction, modifying it to the extent of sectioning

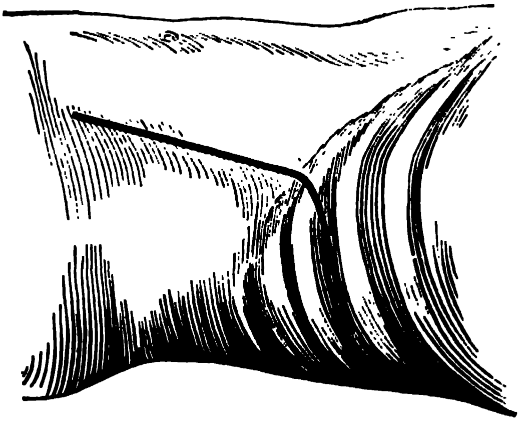

Fig. 2.—Auvray's Incision for Splenectomy.

the cartilages anteriorly and incising slightly in the eighth interspace so as to allow of free retraction of the flap outward without actually removing it.

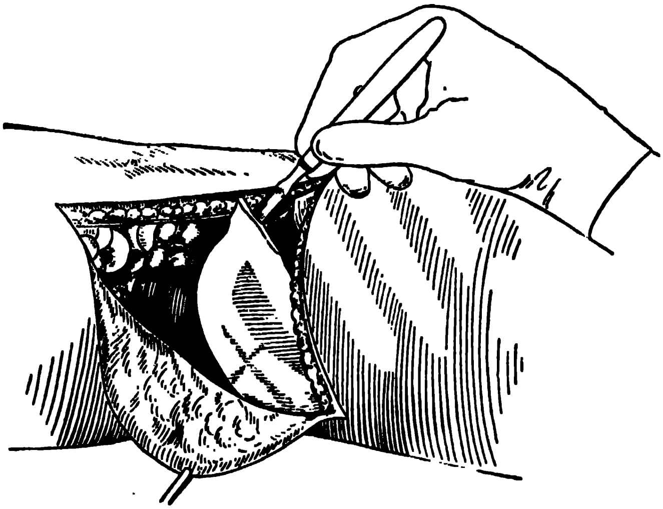

Fig. 3.—Auvray's Operation for Splenectomy. Dissection of the soft parts and excision of the cartilaginous segment.

A third means of obtaining more room in difficult cases consists in carrying an oblique incision outward from the vertical incision and parallel to the costal margin. Such an additional incision is also of much value in cases in which the primary incision has been an exploratory one in the midline of the abdomen. In this event the oblique incision will necessarily have to be a rather long one. Even with this long oblique incision combined with the median incision manipulation may be difficult; the incision to the outer side of the rectus is far preferable.

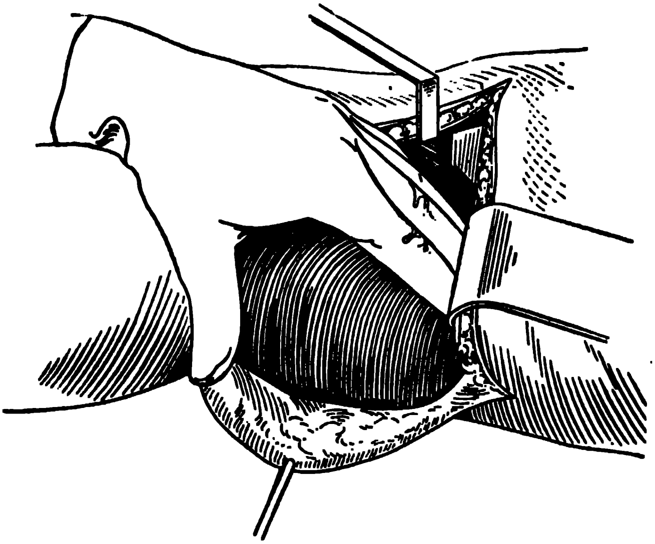

Fig. 4.—Auvray's Operation for Splenectomy.

Technic of Formal Splenectomy. — In non-adherent spleen the operation is comparatively simple. The main considerations are *gentleness in handling* the organ to avoid injury to the spleen itself; *avoidance of stretching the pedicle* forcibly or suddenly in delivering the spleen through the wound, to avoid rupture of the splenic vein; *support of the spleen* after delivery for the same reason; double ligation in sections of the phrenosplenic ligament when vascular; individual ligatures, 6 to 12, of the splenic vessels; and the avoidance of injury to the tail of the pancreas during ligation of the pedicle. In adherent spleen, to the above considerations is added the necessity for care in separating adhesions to other viscera.

Having made an incision which suitably exposes the spleen—in simple cases the straight incision already described, in adherent cases the Auvray or Mayo extension—the left hand is passed over and around the spleen and the existing conditions accurately determined. Jonnesco advises that the operator stand to the right of the patient, in which case the exploration is made with the right hand. This position of the operator is advised by Jonnesco on account of the greater ease of dealing with the pedicle. The costal margin is now forcibly elevated and retracted to the left with a broad retractor, the upper part of the incision at its inner aspect is retracted to the right, thus exposing the upper pole of the spleen. The phrenosplenic ligament is felt and inspected and, if vascular, doubly ligated and sectioned. To facilitate this, the spleen is pressed downward and inward (Fig. 4). Adhesions limited to the diaphragmatic area are separated by the fingers, and the spleen gently delivered through the wound without strain on the pedicle. Fortunately in large spleens the ligaments are usually stretched so that this maneuver is not as difficult as it seems at first sight. In delivering the spleen through the wound, the lower pole is first delivered (Fig. 5), then the upper pole. Immediately the spleen is delivered, a large, hot gauze pad is placed against the site of the diaphragmatic adhesions to check oozing. The spleen is supported by an assistant and gently lowered to the left. This puts the pedicle somewhat on the stretch and allows its ligation under inspection. The stomach will show in the upper right side of the incision, the colon in the middle and lower part of the incision.

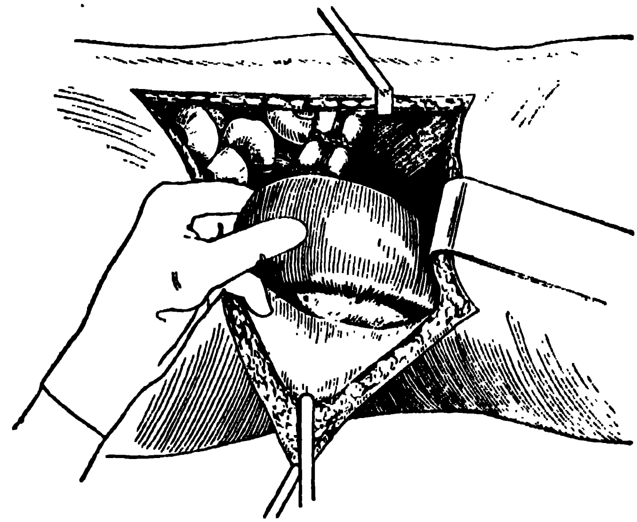

FIG. 5.—AUVRAY'S OPERATION FOR SPLENECTOMY.

All adhesions are now double ligated and sectioned. Warm moist gauze pads are placed to protect the viscera. The pedicle itself is temporarily secured by a rubber-covered gastro-enterostomy clamp (Mayo) at a sufficient distance from the spleen to allow of the ready application of the ligatures controlling the pedicle (Fig. 6). If other viscera are caught in the clamp, no injury results; this is an important reason for using this kind of a clamp. The pedicle is now divided into several parts and each portion double ligated as close as possible to the spleen itself. Jonnesco advises the use of the fingers rather than an instrument in separating the vessels of the pedicle preparatory to double ligation, to avoid injury. If an atheromatous condition of the vessels exists, care must be taken not to ligate them too forcibly. The pedicle is now sectioned between the ligatures and the spleen removed. Exceptionally it may not be possible to apply double ligatures on account of lack of room. This is of no special disadvantage, except as it permits soiling of the operative field by blood from the spleen. The clamp is now loosened but not removed, and any additional bleeding points are secured. Finally, the raw surface of the stump is sewed over, the clamp is removed, and the stump is allowed to slip back (Fig. 7). The diaphragmatic pack is removed, and any bleeding points on the diaphragmatic vault secured by suture. This latter is facilitated by broad retraction of the stomach and intestine to the right and downward, and of the costal margin to the left and upward. The field of operation is now reviewed, clots removed and the wound completely closed save in those exceptional cases in which oozing from the diaphragmatic adhesions necessitates tamponade. If hemorrhage from the spleen occurs during the operation, due to injury of the splenic tissue, the best method of control is to immediately bring the spleen outside the abdomen, at the same time grasping the pedicle.

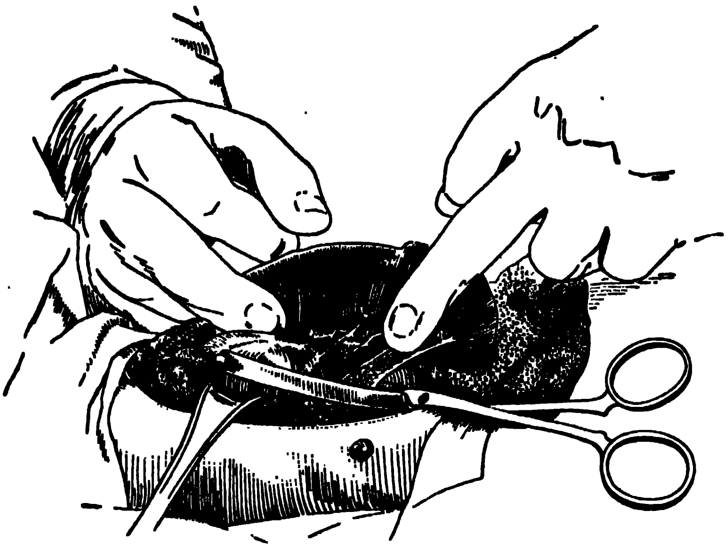

FIG. 6.—AUVRAY'S OPERATION FOR SPLENECTOMY.

Splenectomy in Injury.—In rupture or wounds of spleens of normal size and position, it is important that the incision be properly placed so that the necessary manipulations may be carried out quickly. If a median exploratory incision has been used, the necessary oblique incision should be quickly added to it. To be of avail, the operation must be performed early. No time should be lost in arresting the hemorrhage. Immediately the source of the bleeding has been ascertained to be the spleen, the pedicle of the spleen should be grasped between the fingers and further hemorrhage prevented. This is particularly important, for, as soon as the abdomen is opened, the relief of intra-abdominal pressure afforded by the incision renders bleeding from the injured spleen more forcible. In ruptures and injuries to enlarged spleens the incision will be more apt to be properly placed by reason of the easier diagnosis.

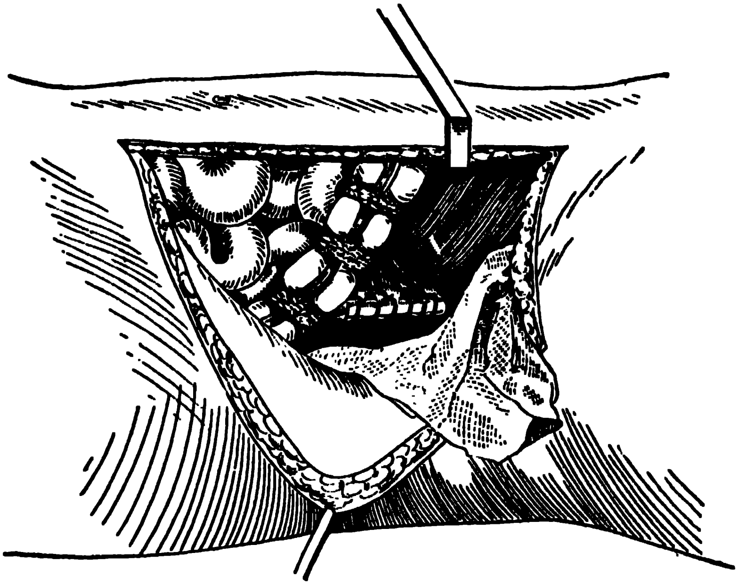

FIG. 7.—AUVRAY'S OPERATION FOR SPLENECTOMY.

Having temporarily controlled the hemorrhage by finger pressure of the pedicle, **which must not be left unguarded for an instant**, the fluid blood and clots are rapidly cleared away and the extent of the injury is noted. If the injury is too extensive for repair—and most injuries are—splenectomy is at once proceeded with. The spleen is separated from all of its normal attachments, and in the case of an already diseased spleen, from all adhesions, in the same manner as in formal splenectomy, except that the pedicle is grasped and the spleen brought into the wound and swung to the left, thus exposing the pedicle. The splenic tissue is usually quite friable and by reason of the injury often mushy. If a clamp has been substituted for the fingers to grasp the pedicle before delivery of the spleen through the wound, it should be of the gastro-enterostomy type with its blades covered by rubber tubing to prevent possible injury to adjacent viscera, which, in the haste of application, may be grasped with the pedicle. The pedicle, if not previously clamped, is *now clamped and, since this is done visually, any reliable clamp may be used, though a gastro-enterostomy clamp is preferable. If the condition of the patients permits, the pedicle is secured as in formal splenectomy; otherwise, it is transfixed,* care being taken not to injure the vessels, and is tied in 2 sections. A Balance and Edmund's stay knot is used for this purpose. The clamps and the ligatures should be placed as near the hilum as possible. The clamps are loosened, the pedicle is inspected, and, if all bleeding has been arrested, the pedicle is allowed to slip back. The diaphragmatic pack, as used in formal splenectomy, has by this time absorbed considerable of the effused blood. The remaining free blood and clots are rapidly removed, the diaphragmatic vault inspected, and bleeding areas, if any, secured by suture. The abdomen is filled with warm saline solution and the wound closed without drainage.

In a *hypertrophied spleen, the site of injury,* removal may be extremely difficult, both on account of the friability of the organ and on account of adhesions. In some cases it is necessary to first ligate or clamp the pedicle and begin the separation of the organ at this point. In cases in which splenectomy is impossible, an attempt should be made to ligate the pedicle or, failing this, to clamp it, leaving the clamp *in situ.* Failing all else, tamponade should be made, but it is at best a make-shift.

Procedures Other than Splenectomy in Dealing with Injuries to the Spleen.—If the wound or laceration of the spleen is quite small or clean cut, suturing may be employed, but this will only exceptionally be found possible. Splenectomy will always be the method of choice in most cases. A round needle, with a suture just a trifle larger than the caliber of the needle, should be used, and great care and gentleness must be exercised that the sutures do not cut through. Sutures should not be tied tightly, but just snug enough to secure accurate apposition of the surfaces, which is essential. One objection to suture methods is that injuries of the under surface of the spleen are apt to be overlooked. Where injury to the spleen is co-existent with other serious injuries requiring operation, it may be permissible to use sutures to close the wound in the spleen if it is of a nature suitable for accurate closure. In cases where the capsule is torn loose, the thermocautery has proved useful in controlling oozing. The omentum has been successfully used (Lange) to control bleeding by packing it into the splenic wound in the case of a stab wound. Gauze tamponade has rarely proved successful, and is to be deprecated except as a last resort in cases too adherent to permit of splenectomy. In experiments on dogs, carried on by Sheldon, rubber-covered clamps were applied to the pedicle of a traumatized spleen for 4 hours; upon removal of the clamps, hemorrhage did not occur. No packing was employed.

Splenectomy for movable (ectopic) spleen is a comparatively simple procedure on account of the greatly elongated pedicle. In some cases, however, in which the ectopic spleen has become fixed by adhesions, splenectomy may be very difficult.

Splenectomy in Traumatic Hernia of the Spleen.—Cases of traumatic hernia of the spleen are so rare as to be surgical curiosities. In very recent cases without injury to the spleen the organ may be cleansed, the wound enlarged if necessary, and the spleen gently replaced; under other circumstances the spleen is removed. In recent cases this is not a formidable procedure. In cases in which the condition has existed for some time, the pedicle is ligated and, if not already firmly fixed in the abdominal wound by adhesions, is secured there by suture. In the rare cases of gangrene of a herniated spleen the thermocautery is useful in the removal.

Splenectomy in Acute Torsion of the Pedicle in Movable Spleen.—While, as shown by Senn, regeneration of spleen tissue is possible, it is not wise to resort to any form of operation other than splenectomy, even in cases in which the torsion is not complete. The risk of gangrene, embolism, or, at the very least, recurrence of the condition is too great, while the value of the spleen to the organism is too small in comparison.

TECHNIC.—The incision *in cases in which the diagnosis has been made* (these will be in the majority, as the character and location of the tumor and the usual occurrence of the lesion in persons who are known to have an enlargement of the spleen, will at least suggest the probability of the condition) will be as for formal splenectomy.

The incision *in cases in which the diagnosis has not been made* will be a median exploratory laparotomy, the employment of which will not materially render the removal of the spleen more difficult, for the reason that the previous mobility of the organ has so stretched the ligaments as to make its removal fairly easy. Having extended the incision sufficiently to give ready access to the pedicle and having packed back the omentum and stomach with laparotomy pads to give a clear view of the situation, as well as to soak up any fluid which may be present, the pedicle is untwisted and the spleen brought into the wound. The torsion is usually in the same direction as the hands of a clock. One or several twists may be present. The vessels of the pedicle are seen to be thrombosed. In almost all cases, owing to the great length of the pedicle, the spleen can be brought outside the abdominal wound before untwisting the pedicle, and the entire procedure can be done under direct observation. Adhesions are rarely met with. When present, they are usually omental, recent, and readily freed. Even greater care must be exercised in dealing with the pedicle than in formal splenectomy, as the torsion may have further weakened the pedicle, and tearing of the veins is quite possible, as is also the displacement of the clots in the veins, with subsequent embolism. In applying the rubber-protected gastro-enterostomy clamp to the pedicle, care must be taken to place it proximal to the portion of the pedicle which has been the site of acute torsion, so that emboli may not be displaced. The pedicle is then cut across and the spleen removed. The subsequent treatment of the pedicle is as in formal splenectomy.

In cases operated upon early, the accompanying peritoneal effusion is not infectious and is readily cared for by the peritoneum, so that drainage is unnecessary. The laparotomy pads introduced at the commencement of the operation soak up most of the fluid. Irrigation is unnecessary. In more advanced cases, with impending gangrene, 1 or more cigarette drains may be left in contact with the stump of the pedicle. These may be secured in place by being *very lightly* sutured with fine catgut to the stump of the pedicle distal to the ligatures controlling it. Drainage, if used, is dispensed with in 48 hours or as soon as the sutures securing the drain loosen. Pronounced traction on the drain is to be avoided, though, if the drain has been properly secured, this cannot result in hemorrhage. Diffuse peritonitis is treated by the Fowler position and other adjuncts to the treatment of this complication.

THE AFTER-COURSE.—The mortality is low, 6.2 per cent. in 48 cases collected by Hartmann, although other statistics give a much higher percentage. In practically all cases the peritoneal symptoms immediately disappear upon removal of the spleen.

Complications of Splenectomy.—The after-course is usually uneventful unless the disease for which the operation is done was accompanied by prolonged anemia. In a few cases, pain in the long bones is complained of, and occasionally enlargement of the superficial lymphatics is noted. *Secondary hemorrhage* is apt to occur if the pedicle was ligated *en masse*, especially if the ligature was applied while the pedicle was tense. In the latter event it is due to retraction of the tissues following relief of the tension. The treatment is immediate operation with more exact hemostasis. In those patients already suffering from severe anemia, blood transfusion is essential to success in the treatment of secondary hemorrhage.

INJURIES TO THE PANCREAS.—**The tail of the pancreas is at times so intimately associated with the pedicle of the spleen as to allow its inclusion in the ligature securing the pedicle.** This happened in 3 of 31 splenectomies done by Wm. J. Mayo. In one case about 1½ in. was found attached to the spleen, and the pancreatic duct was plainly visible in the ligated stump. After covering the stump with peritoneal tissue and attaching a drain, it was allowed to drop back into position. No discharge of pancreatic secretion followed. In the second case the tail of the pancreas was found tied in the pedicle about an inch from the tip. As the case was one of splenic anemia and the patient in poor condition, the stump was allowed to drop back without further treatment. In these 2 cases the inclusion of the pancreas in the ligature was accidental. In the third case, in ligating the splenic pedicle in sections, the ligature applied to the splenic artery cut through the vessel on account of the atheromatous condition of the latter, and a second ligature, likewise firmly applied, also cut through. Thereupon a double catgut strand was placed about the entire body of the pancreas about 3 in. from the tail, including the splenic vessels, the pancreas being used to strengthen the walls of the vessels. As this ligature was pulled taut, the pancreatic tissues were considerably crushed; hemorrhage was immediately controlled. A second ligature was applied further to the right in order to prevent, so far as possible, secondary hemorrhage due to softening of the pancreatic tissues and secondary loosening of the ligatures. Mayo says it is probable that a complete separation of 4 in. of the pancreas so ligated occurred. The case made a good recovery.

In connection with the occurrence of this complication, it should be remembered that Coffey demonstrated experimentally that ligation of the pancreatic duct, with or without the surrounding pancreatic tissue, did not result in permanently occluding the pancreatic duct but that regeneration occurred and the duct reunited in a few days.

According to von Herczel, *fever following splenectomy* is due to injury to the tail of the pancreas. For this reason, he advises ligation of the splenic pedicle as close to the spleen as possible. He claims that the injury to the pancreas sets free the fat-splitting elements which produce fat necrosis and a consequent peculiar fever.

THROMBOSIS OF THE SPLENIC VEIN.—The thrombus may extend into the superior or inferior mesenteric vein or both and completely or partially occlude the vessels. Recovery has been reported (Summers) following secondary laparotomy with infolding of the gangrenous intestinal areas and drainage. The prevention would seem to be more gentle operative manipulation of the pedicle. The symptoms are those of shock, abdominal pain and vomiting. The possibility of the complication should always be borne in mind.

GASTRO-INTESTINAL HEMORRHAGE.—Gastro-intestinal hemorrhage may follow splenectomy. This is a serious complication, attributed by Leiblein to thrombosis of the short branches of the splenic artery. To avoid this, the arteries should be tied close to the hilum.

Statistics.—The table on page 310 is a compilation of the cases collected by Bessel-Hagen to 1900, George Ben Johnston, 1900 to 1908, and Deaver and Ashhurst, 1908-1912.

Excluding from the Bessel-Hagen-Johnston table those cases in which splenectomy was done for leukemia, injury, or miscellaneous conditions, there remains a total of 496 cases, of which 398 recovered and 98 died, a mortality percentage of 19.75.

Deaver and Ashhurst's collected statistics of all cases of splenectomy from 1908 to 1911 inclusive, give a total of 176 cases, with 37 deaths, a mortality percentage of 21.02. If the 77 cases of injury with 21 deaths are excluded, the mortality percentage is 16.1. Combining these statistics gives a total of 595 cases, exclusive of splenectomy for injury or leukemia, of which 481 recovered and 114 died, a mortality percentage of 19.1.

STATISTICAL SUMMARY

	Total	Recovered	Died	Mortality Percentage
Idiopathic hypertrophy	81	60	21	25.9
Idiopathic hypertrophy, ectopic spleen	64	58	6	9.4
Idiopathic hypertrophy, twisted pedicle	32	24	8	25.
Malarial hypertrophy	165	124	41	24.8
Malarial hypertrophy, ectopic spleen	42	41	1	2.4
Malarial hypertrophy, twisted pedicle	15	13	2	15.3
Splenic anemia	98	77	21	21.4
Cysts, hydatid	29	23	6	20.3
Cysts, non-parasitic	25	24	1	4.
Tuberculosis of spleen	15	12	3	20.
Sarcoma of spleen	15	12	3	20.
Abscess of spleen	9	8	1	11.1
Wounds and injuries	227	155	72	31.7
Total	817	631	186	22.7

Collected statistics such as the above do not give an accurate understanding of the mortality following splenectomy, as fatal cases are not apt to be reported unless of special interest through the pathological findings. Of much greater value are the statistics reported by individuals comprising the total number of cases cared for by them. Of interest in this connection is the report by Richards of 22 cases of splenectomy for Egyptian splenomegaly with 4 deaths, 2 in the final stage of the disease; of 18 cases of splenectomy for splenic anemia by Mayo with a mortality of 11 1/9 per cent.; of 27 cases of splenectomy reported by Mayo, including the above, with a mortality of 7.4 per cent.

SPLENECTOMY IN BANTI'S DISEASE (SPLENIC ANEMIA).—The benefit which the patient derives from splenectomy in splenic anemia depends upon the stage of the disease at which the operation is performed. Done early, the operation is curative. Of 30 cases collected by Banti, including 10 of his own, 4 were operated upon in the first stage of the disease; of these 3 were cured; 22 were operated upon in the second stage of the disease; 13 were cured; 4 were operated upon in the third stage, and 1 was cured. Of 18 cases operated upon by W. J. Mayo, 2 died as a result of the operation, 12 were well from 1 to 7 years after the operation, 2 were improved, 1 died 3 years after the operation, showing improvement until shortly before death, and 1 died 2½ years after operation, cause unknown.

SPLENECTOMY IN EGYPTIAN SPLENOMEGALY.—Of 22 patients operated upon by Richards and Aly Bey, 4 died. Of the fatal cases, 2 had progressed to the stage of ascites and should not have been operated upon, one of them succumbing on the third day with delirium and coma; the other made an apparently complete recovery at first, but on the eighteenth day developed portal thrombosis. Of the 2 fatal cases without ascites, one died of acute dilatation of the stomach; the other sank steadily and died the day following operation. This case had chronic pleurisy, a very fatty heart and kidneys, ankylostoma infection, and extensive bilharziasis of the bladder, ureters, and rectum.

Thus, in this series of cases, there is a mortality of 18 per cent. Excluding the 2 advanced cases with ascites, in which operation was really contra-indicated, the mortality is 10 per cent. This probably represents about the real mortality of the operation when restricted to cases in the preascitic stage. Eighteen cases were successful in that the patients left the hospital in better condition than they entered it. Some of these cases were seen 9 months to 2½ years after the operation and were in good condition, some of them doing hard physical work.

SPLENECTOMY FOR RUPTURE OF THE SPLEEN IN TYPHOID FEVER.—Of the 13 cases of rupture of the spleen in typhoid fever recorded, in only 4 was operation performed and in only 1 of these (Conner and Downes case) was the diagnosis made and a successful operation performed.

SPLENECTOMY FOR SPLENOMEGALY OF THE GAUCHER TYPE.—Of this type of splenomegaly there have been 16 cases reported, verified by operation or at autopsy. In 10 cases splenectomy was performed, with 8 recoveries and 2 deaths. Splenectomy in these cases has resulted in the relief of symptoms.

SPLENOTOMY

Indications.—Splenotomy is indicated in abscesses and in cysts, when splenectomy is impossible on account of adhesions. In the former event adhesions are usually present to a considerable extent, consequently splenotomy is the usual operation; in the latter, splenectomy is the operation of choice and splenotomy the operation of necessity when dense adhesions are present.

Incision.—For purposes of incision, a spleen, the site of a cyst or abscess, may be reached by 1 of 3 routes: by an abdominal incision, by a kidney incision carried more forward and more parallel to the ribs than the ordinary kidney incision, or by resecting the ninth or tenth ribs in the postaxillary line and going through the pleura and diaphragm. The incision should be made where the bulging of the tumor is most prominent.

Technic in Abscess of the Spleen.—In abscess, in case an abdominal incision is used, if adhesions have not formed to an extent sufficient to protect the abdominal cavity, the peritoneum is protected by laparotomy pads and the incision made through the splenic tissue and into the abscess by means of the thermocautery. Great care and gentleness are necessary on account of the friability of the spleen. Usually, owing to its friability, it is impossible to suture the edges of the opening in the spleen to the abdominal wound. It is, therefore, necessary that very careful packing be made between the spleen and the abdominal wound in order to promote adhesions. Where possible the operation should be done in 2 stages, first introducing packing to promote adhesions and after 24 to 48 hours opening the spleen with the thermocautery. In many cases the spleen is already so broken down that delay will not be practical and one must be content with opening the abscess and lightly packing it. In some cases it will be found that the spleen is much disorganized, a great mass of splenic tissue seeming to lie in the abscess cavity. In such cases the loose tissue is gently removed. Irrigation should not be employed on account of the danger of hemorrhage. Secondary hemorrhage is always imminent in these cases and in the course of the after-treatment large masses of splenic tissue may come away. If the abscess has a fairly well-defined wall or zone of inflammation about it, tube drainage is indicated. In case a transpleural incision is used, a sufficient excision of the ninth or tenth ribs, or both, is made to give access to the spleen. This incision is carried through the pleura, the opposing cut edges of the pleura being sutured to prevent infection of the pleural cavity, and the incision is then deepened through the diaphragm down to the spleen. Here again it is advisable to pack and wait 24 hours before incising the spleen. If this is not possible, the spleen must be immediately opened and the abscess cavity treated as above. The same principles are to be observed in case a kidney incision has been used. This incision has been used quite frequently on account of mistakes in diagnosis.

Technic in Cysts of the Spleen.—Occasionally cysts are encountered which it is not advisable to extirpate on account of the difficulties and dangers attendant on such a procedure, for example, adherent serous, blood, and echinococcus cysts. In such cases the cyst wall is attached by suture to the abdominal wall, and either opened immediately or after 48 hours have elapsed to allow of the formation of protecting adhesions. The latter procedure constitutes essentially an extraperitoneal operation and almost certainly precludes the occurrence of peritonitis through peritoneal contamination by cyst contents. If preliminary suturing is not possible, on account of the friability of the cyst wall or splenic tissue covering it, adhesions may first be promoted by packing, and after 24 or 48 hours the cyst may be opened.

After-treatment of Splenotomy for Abscess.—In cases in which the infection is limited to the spleen, recovery is the rule. The wound is firmly but gently tamponed to guard against hemorrhage. The tamponade is removed on the fourth day, and the cavity lightly repacked every second day. No irrigation should be used for fear of setting up bleeding. Large masses of splenic tissue will slough and come away. These should not be forcibly removed but should be allowed to separate themselves. *Sepsis* is a common complication. *Secondary hemorrhage* is always imminent. The condition of the patient from the time the lesion is recognized is, as a rule, such as to preclude any major operative procedure such as splenectomy. Great care and gentleness are necessary in the management of the wound.

After-treatment of Splenotomy for Cysts.—On account of the large surface of the lining of the sac, in many instances a secreting membrane, and the impossibility of efficient drainage, asepsis is particularly difficult to maintain. *Healing* occurs by shrinkage and collapse of the sac wall. This latter is hastened by intra-abdominal pressure. Should the healing process, however, proceed too quickly, adhesions will form between adjacent folds of the sac and pockets will result. Fortunately, if such an accident happens, it will be easier for the retained secretions to find an escape through the recently formed adhesions than through the sac wall. Nevertheless, pocketing is to be avoided as much as possible. When shrinkage is complete, the sac cavity is obliterated and the fistulous opening in the abdominal wall closes readily as a rule. The process occupies from 3 to 6 weeks, unless infection has supervened, when a much longer time may elapse before healing is complete.

The most efficient drainage is obtained by a thick-walled rubber tube, 1 in. in diameter, through which is introduced enough sterile gauze to loosely fill the cavity. This prevents too rapid collapse and the subsequent formation of pockets. It does not interfere at all with the shrinkage of the sac. The rubber drainage tube should not extend more than a short distance into the sac cavity. It must not press against the opposite wall of the sac or necrosis and perforation may ensue. A short glass tube with a wide flange to prevent it slipping into the sac cavity may be employed. If of rubber, the tube is held in place by a large safety pin passed through its wall. To the pin is fastened a tape, which is tied around the body or fastened with adhesive plaster. The flanged glass tube will be found more comfortable. The purpose of the tube is twofold, to keep the fistulous tract leading into the sac cavity dilated until complete closure of the sac is effected and to provide drainage for the sac secretions. It is not removed, except for cleansing, until complete closure of the sac has occurred, although a shorter tube may be introduced in its place as healing progresses. It also acts as a safety valve in case pockets have formed. The loose gauze packing is removed at the end of 48 hours and a smaller amount of gauze introduced. This gauze is changed twice daily, once daily or every other day, according to the amount of secretion, until complete closure is effected. Plain gauze fulfills every indication and promotes the formation of granulations. At each dressing a smaller quantity of gauze is introduced *pari passu* with the decrease in the size of the cavity. The outer gauze dressings are changed as frequently as soiled. Drainage will be facilitated by frequently changing the position of the patient. Should infection supervene in spite of every precaution, disinfecting measures must be introduced. Irrigation will be found the most efficient of these. According to the amount of the discharge and the virulence of the infection, the cavity may be irrigated with saline or borosalicylic solution once, twice or thrice daily, the gauze packing being renewed at each irrigation. The employment of stronger antiseptics is not justifiable, as they tend to increase the necrosis of the sac wall, and from such a necrosis, perforation and peritonitis may result. Prolonged suppuration here, as elsewhere, will cause great deterioration in the health of the patient and may even result in death. Asepsis must be rigid throughout the entire course of wound healing. After removal of the tube, the resulting fistula is stimulated to promote more rapid closure.

Echinococcus Cysts.—Echinococcus cysts are treated on the same principle as other cysts, but in order to effect a cure the sac lining containing the echinococcus hooklets must be either removed or destroyed. This latter is not surely effected by shrinkage of the sac, and the introduction of chemicals of sufficient strength to destroy the lining membrane is dangerous. The procedure which has met with greatest success consists in the gradual separation of the mother sac from its fibrous capsule by allowing a stream of saline solution to flow between them. Some 7 to 14 days may be occupied by this procedure, the mother cyst being gently and gradually separated until finally it is entirely removed. A rapid shrinkage of the fibrous capsule follows. The cavity is irrigated daily with mild iodin solution. Should *calcification* occur in the cyst lining, the calcareous deposits must be removed with a sharp curet, or healing will be greatly prolonged and a persistent fistula will result.

SPLENOPEXY

Indications.—Fixation of the spleen is rarely indicated, a movable spleen usually being diseased and, therefore, requiring splenectomy. In movable spleen not the seat of disease palliative treatment may be tried. A belt may be applied of the same character as that used in the treatment of movable kidney. Should this not retain the spleen in position and cause complete relief of the symptoms, *splenectomy* is not only justifiable but it is to be advocated, if for no other reason than that it protects the patient against the danger of torsion of the pedicle. Splenectomy is preferable to splenopexy, as the latter does not in most instances entirely relieve the symptoms.

Lanz cites a case in which ligation of the splenic artery in a case of ectopic spleen too adherent to allow of removal effected cure, probably by atrophy of the spleen.

Technic of Splenopexy.—(1) An oblique abdominal incision parallel to the ribs is made, 12 cm. long; (2) a peritoneal diaphragmatic pocket is formed by a transverse incision of about 10 cm. through the peritoneum on the inferior surface of the diaphragm at the level of the tenth and eleventh ribs. The length of this incision corresponds to that of the anteroposterior diameter of the spleen. The inferior lip of this incision is dissected over a sufficient area to form a pocket for the spleen. (3) The lower pole of the spleen is slipped into this pocket and there fixed. To prevent the pocket from enlarging, the peritoneum at the bottom of the pocket is attached to the underlying tissues by a few catgut stitches. A similar pocket may be made by dissecting the upper lip of this incision and the spleen may be placed therein, the peritoneal incision being closed down to the pedicle (Guibe).

RYDYGIER'S METHOD.—A median abdominal incision is made and the peritoneum is incised between the tenth and eleventh ribs. A pocket is then formed behind the peritoneum into which is placed the lower pole of the spleen. The gastrosplenic ligament is sutured to the free border of the pocket.

BARDENHEUER'S METHOD.—An incision is made in the axillary line from the tenth rib to the iliac crest. The incision is deepened as far as the peritoneum, which is first dissected out to each side of the abdominal wound and then opened. The spleen is brought through this opening, and the peritoneum sutured down to the hilum. Additional sutures secure the spleen to the tenth rib.

SCHIASSI'S METHOD.—A vertical incision is made 15 to 20 cm. in length, and is extended parallel to the left costal margin transversely to the right. The omentum is sutured on the superior and inferior lateral edges of the rectangular flap and from 3 to 6 sutures are applied, securing the spleen to the abdominal wall.

OTHER METHODS.—*Tuffier* sutures the spleen to the diaphragm or to the abdominal wall. *Kouwer* fixes the spleen by surrounding it with gauze to promote adhesions.

After-treatment of Splenopexy.—These patients should be kept in bed for 4 weeks and should recline for the most part on the left side, with the foot of the bed somewhat elevated. A supporting binder should be worn for 3 months. Corsets affording proper support should be advised.

Exosplenopexy consists in suturing the spleen outside the peritoneal cavity in the abdominal wall, with the idea of gradually causing its elimination.

SPLENOCLEISIS

Splenocleisis (Schiassi) has been advised in splenic anemia. It consists in surrounding the enlarged spleen with iodoform gauze, with the idea of producing adhesions through the contraction of which it is hoped that reduction in the size of the spleen will occur and also that venous anastomoses will result and divert the blood from the spleen. The results of splenectomy in splenic anemia are, however, so excellent that no other operation need be considered.

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CHAPTER VII

OPERATIONS UPON THE SMALL INTESTINE, MESENTERY AND OMENTUM

RUSSELL S. FOWLER

SURGICAL ANATOMY OF THE SMALL INTESTINE

Position of Small Intestinal Loops.—Boese and Hegrovsky (3) state from a series of X-ray examinations on the small intestine that individual coils of the small intestine remain in a fairly constant position. Their experiments were carried out by placing in the peritoneum small foreign bodies, such as shot and needle points, and then determining their position by means of the X-rays. They found that any given loop maintains physiologically its own place in the abdominal cavity. Periodical regular movements could not be demonstrated, nor did their method show any regular contraction of the intestines.

Intestinal Localization.—In operations upon the small intestine, it is of importance in many cases, in order to lessen the time of operating as well as for other reasons, to know approximately what portion of the intestine is being handled. This is particularly true in cases of obstruction and perforation, in anastomosis operations, in enterostomy, or in cases in which one wishes to trace the intestine up or down from a presenting loop.

LOCALIZATION OF THE DUODENUM.—With the exception of the first portion, the duodenum is entirely retroperitoneal. The first portion, continuous with the pylorus, is easily reached above the transverse colon and to the left of the gall-ducts. The descending portion is best exposed by dividing the outer layer of the ascending mesocolon throughout its upper third when, by rolling the ascending mesocolon, together with the pylorus, toward the patient's left, the outer and posterior walls of the descending portion of the duodenum are brought into view. To expose the transverse portion of the duodenum, the least dangerous course is to divide the inferior layer of the mesentery of the small intestine just above the bifurcation of the aorta; this gives access to the duodenum as it crosses the spinal column immediately below the superior mesenteric vessels. In Jaboulay's entero-anastomosis the transverse portion of the duodenum on the right of the superior mesenteric artery is utilized.

LOCALIZATION OF THE FIRST PORTION OF THE JEJUNUM.—The trans-

verse colon is drawn out of the abdominal incision and, by steady traction to the right and upward, the mesocolon **is brought out until the jejunum comes into view. On drawing the jejunum tight, the fold of peritoneum which forms the ligament of Treitz is shown. This peritoneal band has its origin on the transverse mesocolon and extends down on to the beginning of the jejunum, acting as a suspensory ligament. It is an important landmark, as it leads to the base of the vascular arch of the middle colic artery and accurately marks the place in the transverse mesocolon through which the stomach wall may be drawn in posterior gastro-enterostomy. From its origin the jejunum comes directly backward and to the left into the left kidney pouch beneath the splenic flexure of the colon. At its origin the mesentery of the first portion of the jejunum lies posterior, and the free surface of the intestine is directed anteriorly.**

The ligament of Treitz is usually small but may extend several inches downward upon the anterior surface of the jejunum. In using this portion of the jejunum in the no-loop operation of posterior gastrojejunostomy, it is necessary that any considerable formation of the ligament of Treitz be freed from the anterior surface of the gut. The duodenojejunal fossa, present in about 48 per cent. of cases (Deaver, 8), is below and to the left of the terminal portion of the duodenum.

LOCALIZATION OF THE REMAINDER OF THE SMALL INTESTINE.—There are 2 points which it is desirable to know concerning the localization of the remainder of the small intestine: First, the approximate position of the loop in question; second, the direction of the loop. Monks (26) has, in a study on the cadaver and also on the living subject, determined certain facts regarding these points which are of value in operative work on the small intestine. The results of his investigations, which have been confirmed by later experience, show that the approximate localization of a loop of the small intestine and the determination of the natural direction of that loop are quite possible. It must be remembered, however, that the condition of the intestine in life, especially when modified by physiologic changes, by extreme distention, adhesions, acute inflammatory conditions, ascites or tumors, may render localization and the determination of the direction uncertain. In the presence of infection, for example, the danger of spreading the infection would prohibit a thorough examination of the deeper parts of the mesentery, this latter being one of the aids in the determination of the direction of the gut. It is not possible by any method to make accurate localization, but approximate localization can be made, and this is better than no localization at all.

1. LOCALIZATION OF THE LOOP.—Roughly it may be stated that the upper third of the small intestine, beginning at the end of the duodenum, is located for the most part in the left hypochondrium; the middle third of the small intestine is probably in the middle section of the abdomen, while the lower third is probably in the pelvis and right iliac region. Taking the average length of the small intestine from the end of the duodenum to the end of the ileum as 21 ft., Monks divides the gut into 3 parts and differentiates these parts from each other

through the differences in the intestine itself and in the mesentery. The characteristics of the intestine which are noted are size, thickness, translucency, vascularity, color, the feel of the valvulæ conniventes, contents, and the resistance at the 2 ends of the bowel. As regards the mesentery the differentiation is made as to thickness, translucency, lunettes, tabs of fat, size of vessels, length of the vasa recta, regularity and course in the distribution of the vasa recta, number of branches to the mesentery, mesenteric loops, the part of the mesenteric root indicated by the stretched mesentery, and the point of resistance in reference to the median line, this latter being of value only if the incision is in the median line.

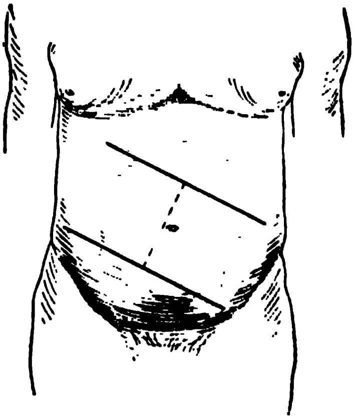

FIG. 1.—DIAGRAM DEFINING UPPER, MIDDLE AND LOWER THIRDS OF SMALL INTESTINE. Two oblique lines (black) are drawn at right angles to the two extremities of the line (dotted) of the mesenteric root. The upper, middle, and lower compartments here indicated contain respectively in most instances the upper, middle, and lower third of the small intestine. (Monks.)

Taking up in order the various points which are to determine the difference between the sections of intestine, Monks considers first what part of the small intestine we may expect to meet in any one of the various abdominal incisions. It was found that in normal conditions the upper 6 feet or so of the jejunum is confined to the left hypochondriac region, occupying the deep fossa under the ribs in such a position that these coils would not usually be encountered through any of the ordinary abdominal incisions. The middle part of the intestine usually occupies the central portion of the abdomen, while the lower part is generally in the pelvis and in the right iliac fossa (Fig. 1). An incision anywhere above the upper line will probably disclose loops belonging to the upper third of the intestine; an incision near the second line will disclose loops belonging to the middle third, while an incision below the second line will disclose loops belonging to the lower third. While this is usually the rule, there are occasional and marked exceptions.

The second point for consideration is the length of the intestine. The length of the intestine varies greatly in different individuals and bears no known relation to the age or sex. Of the subjects examined by Monks, the shortest intestine was 15 ft., the longest 29 ft., the average being about 21 ft. It was noted in several instances where the intestine was very long that the mesentery was also of unusual length and that the vasa recta were longer than the average. It was also noted in a few cases where the intestine was shorter that the mesentery and vasa recta were also inclined to be short. Occasionally it was possible to estimate with some success the approximate length of the bowel by localizing the first loop and by putting the mesentery gently on the stretch and examining the vasa recta to determine whether the mesentery and vasa recta were longer or shorter than the average for that part of the tube; if longer, it was estimated that the intestine was above the average, that is more than 21 ft.; if shorter, it was considered probable that the intestine was below the average, less than 21 ft. This part of Monks' investigation, however, has not been worked out fully enough to be reliable.

Size of the Intestine.—Normally the diameter of the gut is greatest above and gradually diminishes in size downward to the lower third, where it remains about the same for the remainder of the gut. The diameter varies so much, however, under pathological conditions of contraction or distention that a knowledge of the different diameters would not be of much value.

Thickness of the Intestine.—Due to the presence of large and numerous valvulæ conniventes and the great development of the muscular layers, the upper part of the small intestine is normally thicker than any other part. The thickness gradually decreases until the lower third of the gut is reached, where it remains about the same until the lower 2 or 3 ft. of the ileum, where it again increases, due to the increase in the musculature of the gut at this point. Again, this normal thickness cannot serve alone as a guide in pathological conditions, for chronic obstruction may cause an increased thickness due to hypertrophy of the muscular walls of the gut, while distention by gas greatly increases the apparent size, with consequent apparent diminishment of the thickness of the wall.

Color and General Vascularity.—The upper part of the bowel in a normal condition is bright pink or red and exhibits a great number of branching vessels of good size. As we go down the tube, the color gradually fades, and the vascularity grows less and less marked.

Valvulæ Conniventes.—In the upper part of the bowel these are large and numerous and can be readily felt, and generally seen as pinkish or whitish rings, more or less complete, about the gut. They gradually decrease in number, and especially in size, until a point is reached which Monks determined to be about 14 or 15 ft. from the duodenum, beyond which they are seldom felt or seen, although the distance to which they extend varies somewhat. This variation has apparently nothing to do with the variations in the length of the tube.

Contents of the Intestine.—Food, if present, increases somewhat in consistency toward the lower end of the intestine.

Resistance at the Two Ends of the Bowel.—When one end of the loop which is high up in the abdomen is gently pulled upon and resistance is felt, the loop is probably close to the duodenum. When one end of the loop low down is pulled upon and resistance is met with, the loop is probably a short distance from the ileocecal valve.

General Vascularity of the Mesentery Near the Bowel.—Opposite the upper portion of the bowel the mesenteric vessels are distinctly larger than opposite any other part of it. These vessels grow smaller and smaller as we progress downward, until the lower third of the gut is reached, where they remain about the same size as far as the ileocecal valve. The main branches of the superior mesenteric artery unite with each other by means of loops which are called for convenience primary loops; in some parts of the tube, secondary loops and occasionally even tertiary loops are superimposed upon these. From these loops the vasa recta run to the bowel, upon which they ramify, alternating, as a rule, as to the side of the intestine which they supply. The mesenteric veins are arranged in a manner somewhat similar to the arteries.

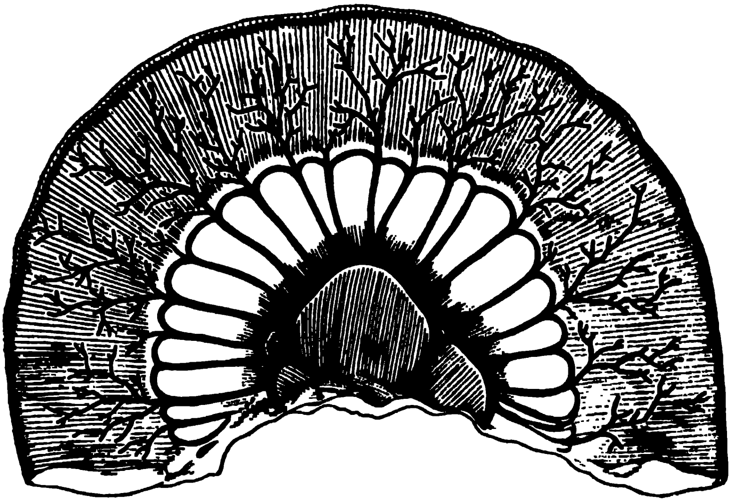

FIG. 2.—LOOP OF INTESTINE THE MIDDLE OF WHICH IS EXACTLY 3 FEET FROM THE END OF THE DUODENUM. (Monks.)

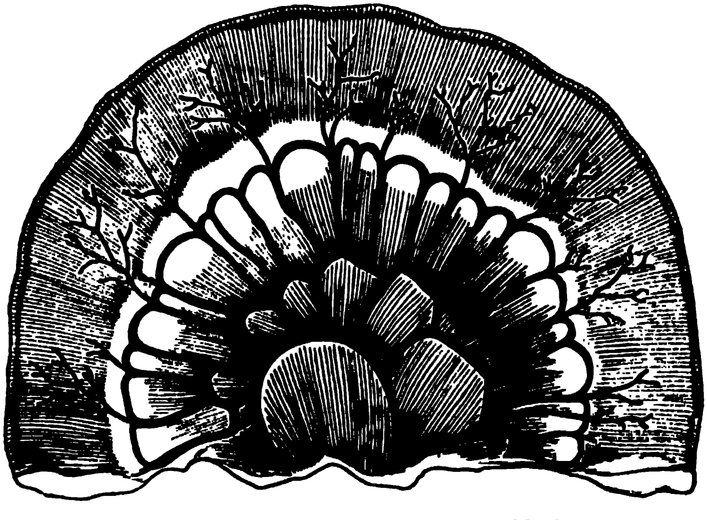

FIG. 3.—LOOP OF INTESTINE AT 6 FEET. (Monks.)

The Loops of the Mesenteric Vessels.—Opposite the upper part of the bowel, there are only primary loops; occasionally a secondary loop appears but it is small and insignificant as compared with the primary loops, which are large and

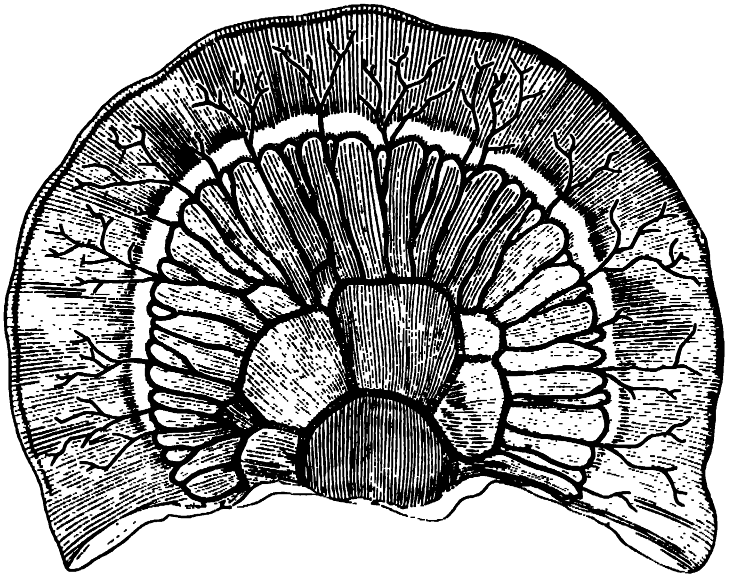

FIG. 4.—LOOP OF INTESTINE AT 9 FEET. (Monks.)

quite regular. Lower down the secondary loops become more numerous, are larger, and approach nearer to the bowel than the primary loops in the upper

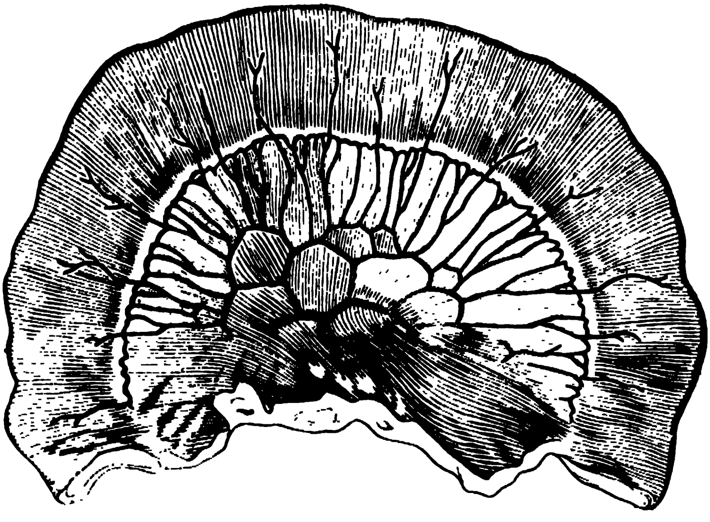

FIG. 5.—LOOP OF INTESTINE AT 12 FEET. (Monks.)

part. As a rule, secondary loops become a permanent feature at about the fourth foot. Further downward the secondary, and possibly the tertiary, loops become still more numerous and the primary loops smaller, the loops constantly getting nearer and nearer the gut. Opposite the lower part of the gut,

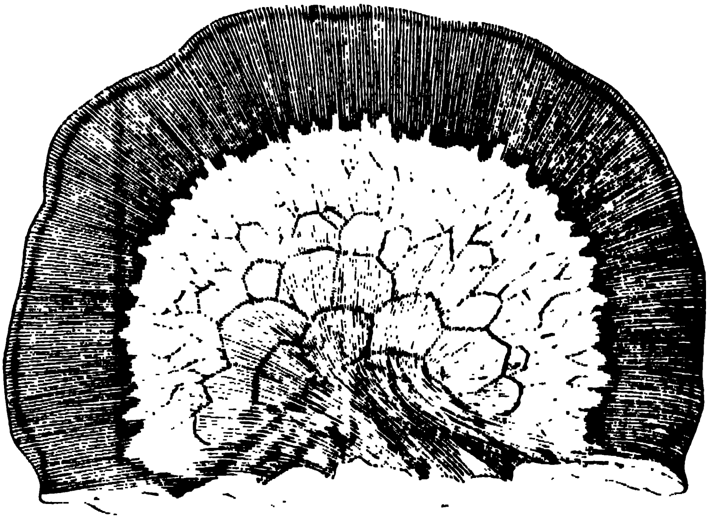

Fig. 6. Loop of Intestine at 17 Feet. (Monks.)

the loops generally lose their characteristic arrangement and are represented by a complicated network.

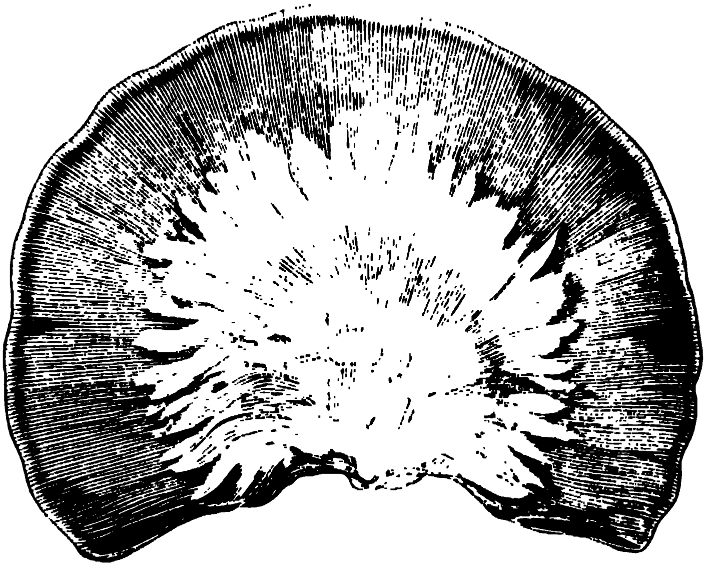

Fig. 7.—Loop of Intestine at 20 Feet. (Monks.)

The Vasa Recta. Opposite the upper part of the intestine, the vasa recta are seen to be 3 to 5 cm. long when a loop of the small intestine on which they run is lifted up so as to put them gently on the stretch. They are straight, large and regular, and rarely give off branches in the mesentery. In the lower third they are very short, being generally less than 1 cm. in length. Here they are less straight, smaller, and less regular and have frequent branches in the mesentery.

Thickness and Translucency of the Mesentery.—Both the thickness and translucency of the mesentery vary materially in different subjects. The more fat the more opaque, and vice versa. The thinnest part of the mesentery is adjacent to the upper part of the intestine; lower down the adjacent mesentery becomes thicker and thicker, due apparently to a deposition of fat and to the presence of a ligament of fibrous and plain muscular tissue which is thought to aid in the support of the lower coils of intestine. In the upper part of the mesentery and intestine we find the thinnest part of the mesentery opposite the thickest part of the tube, and further down we have the thickest part of the mesentery opposite the thinnest part of the tube. The translucency varies enormously. At times the mesentery in the upper part is so free from fat as to be quite transparent, and in thin individuals the mesentery may transmit some light at any part. In other cases it is quite opaque, especially below, where there may be so much fat in adipose subjects as to conceal the vessels entirely. Monks found one point, however, common to all cadavers which he examined. If a loop of the uppermost part of the intestine is raised and held in such a position as to permit light to shine through the mesentery, it will be noticed that in the portion of the mesentery closest to the gut little transparent spaces exist between the vasa recta. These he calls *lunettes.* They are almost always present opposite the upper part of the gut, even in the thickest mesenteries. They gradually grow smaller, become streaked with fat, and disappear at about the eighth foot. In occasional cases they may persist to the end of the gut.

Tabs of Fat Close to the Mesenteric Border of the Intestine.—In that part of the mesentery adjacent to the lower third of the gut there are usually found, except in the thinnest subjects, little masses of fat which project from the mesentery toward the bowel or even extend upon it. In one very fat subject these tabs were present from one end of the intestine to the other.

The various points which have been so far enumerated are shown in the accompanying illustrations (Figs. 2, 3, 4, 5, 6, 7).

Direction of the Stretched Mesentery.—By gently pulling upon the loop of presenting intestine in such a direction as to pull away from the known line (Fig. 1) of the mesenteric attachment an approximate idea as to the part of the mesenteric root which responds can be obtained by noting the direction of the line of resistance. This will suggest to which part of the intestinal tube the loop belongs. The value of this test is more noticeable when made through incisions which make it possible to pull the loop at right angles to the mesenteric root than through incisions where the pull is oblique.

In median incisions pulling the loop of intestine downward will determine with considerable certainty whether the line of resistance from above is from

TABLE SHOWING THE USUAL CHARACTERISTICS IN INTESTINE OF TWENTY-ONE FEET

		Upper Third	Middle Third	Lower Third
Usual Position in the Abdomen of the Different Thirds of the Intestine		Left Hypochondrium	Probably in Middle Section of Abdomen	Probably in Pelvis and Right Iliac Region
Intestine	Average length of intestine	1 2 3 4 5 6 7	8 9 10 11 12 13 14	15 16 17 18 19 20 21
	Size	Large		Small—Small
	Thickness	Thick		Thin—Slightly thicker
	Translucency	Opaque		Translucent—Less translucent
	Vascularity	Large vessels and far apart		Small vessels and near together
	Color	Bright pink or red		Pinkish or yellowish gray
	Valv. conn. (felt)	Large and numerous		Cannot usually be felt beyond 14th–16th foot
	Contents	Food in various stages of intestinal digestion		Increasing consistency
	Resistance at two ends of intestine	At duodenum		At ileocecal valve
Mesentery	Thickness	Thin		Thick
	Translucency	Transparent or translucent		Opaque
	Lunettes	Usually to 8 ft. or beyond		None
	Tabs of fat	None		Usually begin at about 14th foot and become more and more prominent
	Size of vessels	Large and far apart		Often obscured by fat Small, close together
	Vasa recta, length	Long (3–5 cm.)		Short (1 cm. or less)
	Vasa recta, regularity in course and distribution	Regular		Irregular
	Vasa recta, number of branches to mesentery	Few, if any		Many branches
	Mesenteric loops	Primary. Secondary usually begin at about fourth foot		Complicated
	Part of mesenteric root indicated by stretched mesentery	Upper part	Middle part	Lower part
	Point of resistance in reference to median line[1]	To left of median line	To the right of median line	

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[1] Only of value through incisions in the median line.

the median line of the body or from the left or right of it. The more the line of resistance when pulled from below downward inclines to the left the nearer is the loop to the duodenum; and the more it inclines to the right the nearer it is to the ileocecal valve.

The table by Monks, page 325, shows the usual characteristics of the different portions of the small intestine.

2. Determination of the Direction of the Loop.—A given loop of intestine is held parallel to the mesenteric root. If the loop has been rotated and there are twists in the mesentery, they are determined by the operator passing his finger first down one side of the mesentery and then down the other. If this digital exploration shows that there is a twist in the mesentery, the bowel is rotated until the mesentery is free from twists. With the mesentery once free from twists and the bowel parallel to the mesenteric root, the end of the loop pointing downward is the one nearest the ileocecal valve. While this idea is original with Monks, it is not a new one, and he gives credit for its previous description to Woolsey (32), and also notes that it is mentioned in Stimson's "Operative Surgery" (30), and referred to by Rand (27) in the London *Lancet.*

Another method of determining whether the mesentery is twisted or not is by pulling upon the 2 ends of the loop, when the twist, if present, will usually show in the mesentery. This latter is of advantage in cases presenting infection since it allows the determination of direction without digital exploration of the mesentery. Failures are possible, as when the wound is so far away from the mesenteric root that the latter cannot be reached with the finger, or when complicated twists or extensive pathological processes prevent proper manipulation or view of the mesentery.

Both sides of the mesentery should be examined, the findings on one side being verified by the findings on the other. At times this may be done with the thumb and fingers of one hand in the following manner. The loop of intestine is gently lifted from the abdominal cavity. With the assistant grasping its 2 extremities and holding it suspended horizontally, the surgeon, placing his thumb on one side of the mesentery and his fingers on the other, insinuates them slowly toward the root of the mesentery, the slack of the mesentery being taken by his other hand and the hands of the assistant. A twist can be determined usually before the mesenteric root is reached. If there is a twist, the loop of bowel is rotated and the mesentery again examined. If there is no twist, when the loop lies parallel with the mesenteric root, the upper end is the proximal end of the loop and the lower the distal end.

LOCALIZATION OF THE TERMINAL ILEUM: MONKS' METHOD.—The forefinger is carried over the psoas muscle and the iliac vessels on the right side, keeping the finger tip close to the parietal peritoneum and so entering the pelvis. The finger is then turned on its own axis and hooked upward, the peritoneum at the back part of the pelvis being followed carefully. In this procedure the finger usually goes behind the ileum, entering the cavity on the left side of the mesentery where the finger comes against the lower side of that structure. The thumb and forefinger then close upon each other, grasping what is between them. When this is brought from among the coils of the intestine it will usually be found to be a loop of the ileum quite close to the ileocecal valve. This is easier of accomplishment if the last part of the ileum is in the pelvis. In about 50 per cent. of the cases, however, the gut lies above the ileocecal valve. With practice, the lower part of the ileum can be traced from its mesentery at the lower end of the mesenteric root.

IDENTIFICATION OF THE PELVIC FOLD IN THE MESENTERY: MONKS' METHOD.—That part of the mesentery which descends into the pelvis from the lower end of the mesenteric root can usually be felt distinctly by the examining forefinger. The determination of this fold is of value as a landmark as a point of entrance in the pelvis to the great fossa on the left side of the mesentery. It is only necessary to push the finger around it. The presence of this pelvic fold may also assist the surgeon in finding the lower part of the ileum.

Visceral Attachment of the Mesentery.—The 2 leaves of the mesentery begin to separate about ⅔ in. from the intestine, leaving a triangular space at the base of the intestine, averaging about 5/16 in. in width, uncovered by peritoneum. This space is filled by the vessels and nerves of the gut and by delicate fibers of connective tissue, together with a varying amount of fat. It is necessary that the surgeon bear this in mind in performing an end-to-end anastomosis as, with this arrangement of the peritoneum, it is obvious that an ordinary suture will not bring the peritoneal surfaces into contact. For this reason special stitches have been devised for securing the intestine at this point.

Relative Functional Value of the Jejunum and Ileum.—This point is of practical importance in resection of the intestine. The jejunum is far more important functionally than the ileum. Conservation of the former is, therefore, necessary, while large portions of the latter may be resected and yet a sufficient length of intestine be left to carry on nutrition properly. Fortunately for the individual, pathological lesions are more frequent in the less important part of the ileum.

Effect of Extensive Resections of the Small Intestine.—Flint's experiments (10) show that in dogs as much as 50 per cent. of the small intestine may be removed without a fatal result. The animals gradually return to a condition of practically normal weight and metabolism when maintained on a favorable diet under good conditions. Resections of 75 per cent. and even more may be survived, but such animals are not liable to show a true recovery. In all cases, the animals suffer at first from severe diarrhea and from ravenous thirst and appetite, from which they gradually recover. Following recovery, however, they remain extremely sensitive to unfavorable conditions of diet and living.

Metabolic studies on such animals show marked increase in the excretion of nitrogenous, fatty and carbohydrate elements. Carbohydrates are absorbed to a degree considerably above normal after compensation is established. An increase in the amount of fats fed may lead to increased elimination of nitrogen and fats. Hypertrophy, as well as hyperplasia, occurs in the portion of the small intestine left. There is no regeneration of either the villi or crypts. By computation it was found that in favorable cases approximately the original epithelial area was restored by the hypertrophic process. It was found that smaller resections than 50 per cent. may be followed by severe metabolic disturbances, and even inanition and death. A study of the literature shows that the results are similar in human beings. The metabolic disturbances bear no relation to the amount of intestine removed. Because of this uncertainty, as small an amount as possible should be resected. The diet of such patients should be poor in fat and relatively rich in carbohydrates and of a readily assimilable character.

ANOMALIES OF THE SMALL INTESTINE

Congenital Anomalies.—These are due to failure of rotation and arrest of development.

ANOMALIES OF THE DUODENUM.—Dwight states that the fixed portion of the duodenum ends in front of or slightly to the right of the vertebral column in 10 to 12 per cent. of adult cases instead of on the left side as is usual. The portion of the duodenum ordinarily retroperitoneal may have a mesentery.

ANOMALIES OF THE JEJUNUM.—In a few cases absence of the mesentery of the upper portion of the jejunum has been recorded. Such anomalies have a practical bearing in gastro-enterostomy. The peritoneal fold of Trietz may extend for a distance of several inches on the convex surface of the jejunum and require section before performing the "no-loop" operation in posterior gastro-enterostomy.

ANOMALIES OF THE ILEUM.—Rarely the longitudinal bands of the colon may extend for some distance on the ileum.

MECKEL'S DIVERTICULUM.—Meckel's diverticulum, the remnant of the omphalomesenteric duct, is found on the free border of the terminal portion of the ileum in the neighborhood of the ileocecal valve, though it has been noted as occurring in other portions of the small intestine. It is said to be present in 2 per cent. of the cases examined. In my experience it is much more rare. It is a rectangular implantation composed of all the coats of the intestine and is more than 2 cm. in length. Its shape varies from that of a thumb-shaped sac with a wide and open base to a narrow-lumened appendix. A terminal filament is at times present which may be free or attached to the abdominal wall, mesentery, or any other part of the intestine. The usual location is within 6 ft. of the ileocecal valve, but it has been found on the jejunum and even on the duodenum. It is of surgical importance through its liability to inflammation and from the fact that it is stated to be the cause of intestinal obstruction in 6 per cent. of cases.

EXCISION OF MECKEL'S DIVERTICULUM.—The treatment for Meckel's diverticulum is excision. As the base is rectangular and large, invagination of the stump following amputation of the diverticulum would not only produce too much narrowing of the small intestine at the point of invagination, thus leading to an obstruction, but, failing this, might also cause an intussusception from the projection of the stump inside the bowel. Complete excision of the diverticulum must, therefore, be practiced, with plastic repair of the opening into the intestine. If this is impracticable on account of inflammatory changes in the intestinal wall itself or because the caliber of the intestine would be too greatly narrowed or kinked, then resection of that portion of the intestine bearing the diverticulum should be practiced, followed by end-to-end or lateral anastomosis. When met with in the course of a laparotomy for other lesions, its removal will depend upon whether there are present any evidences of previous inflammation. If no evidence of previous inflammation is present and if the diverticulum is of the type with a broad open base, the indication for excision is not imperative; otherwise, it should be removed.

Acquired Diverticula.—Hodenpyl (15), in 1900, showed a specimen of diverticulum of the duodenum. Acquired diverticula may be recognized by the following characteristics. They are, as a rule, multiple, small, thin-walled and round or ovoid in shape. They appear as hernial protrusions of the mucous membrane through the fibers of the muscular coat. They are less frequent in the small intestine than in the colon and rectum. Some acquired diverticula have all the coats of the intestine.

GENERAL CONSIDERATIONS IN OPERATIONS UPON THE SMALL INTESTINE

Underlying Principles.—Operations upon the small intestine should be done as far as possible outside the abdomen. The intestines must be handled gently and protected from cooling. Gauze wrung out of hot saline or hot olive oil is useful in this regard. Shock in abdominal operations is largely prevented by the suitable protection of the peritoneal surfaces. The use of olive oil not only protects the peritoneal covering but tends to prevent adhesions. One of the first requisites is skill in the use of the needle and thread. This can be acquired only by practice either upon the intestine of dead animals or, preferably, upon the intestine of the living animal, for in the latter errors in technic can be detected at autopsy.

The underlying principles of operations upon the intestine are the approximation of peritoneal surfaces, the securing of water-tight approximation, the provision for an adequate blood supply and the avoidance of soiling of the peritoneum. No matter what form of suture or mechanical device is used, these principles must be observed.

Prevention of Contamination of the Operative Field.—This is accomplished by means of various forms of intestinal clamps. In placing clamps upon the intestine for the purpose of preventing escape of contents, only sufficient force should be exerted to effect the purpose desired. Very little force is necessary. Crushing must be avoided.

Murphy's clamps are easily applied and do not require rubber covering. The clamps ordinarily used in gastro-enterostomy, Doyen's, Mayo Robson's, and Lane's, are admirable for small intestinal anastomosis clamps. Their blades, except Lane's, are covered by rubber tubing. It is important that the tubing used fit closely, in fact, that it require a little effort to place it on the blade; otherwise the clamp will not hold the intestine securely. If the tubing is a little large there is a tendency for it to rotate on the blade of the clamp. The Willard Bartlett clamp has the advantage of being capable of exerting equal pressure at either end, so that withdrawal of a portion of the loop by slipping is impossible; moreover, the amount of pressure exerted through the set screws at either end is under direct control.

SUBSTITUTES FOR CLAMPS.—In an emergency the mesentery may be bluntly separated near the gut by means of a clamp, taking care to avoid the vessels. Through this opening is passed a piece of tape, a strip of gauze, or a ligature, both ends of which are caught by a clamp and the strand rapidly twisted until closure of the intestine is effected. If a sufficiently long tape is used the clamp does not interfere in the field of operation and its weight prevents untwisting. Maylard's device may be used. This consists of an ordinary anatomical forceps over each blade of which is forced a piece of rubber tubing to within an inch or so of the distal end of the forceps. An aperture is made in the mesentery, taking care to avoid injury to the vessels, and one end of the forceps passed through the opening. The points of the forceps are then held together by a small section of rubber tubing.

Pean's device may be used in the absence of proper clamps. A piece of thin elastic rubber tubing is knotted to one handle of a Pean or other clamp; the point of the clamp, closed, is forced through the mesentery, avoiding injury to the vessels; the clamp is opened, the tubing put upon the stretch and grasped in the jaws of the forceps, which is thereupon clamped. There is thus caused sufficient pressure between the elastic band and clamp to prevent the escape of intestinal contents.

Before the clamps are applied the contents of the intestine at the site of operation should be expressed up and down the tube. Having isolated the site of operation, the remainder of the field is kept from contamination by laparotomy pads or large pieces of gauze wrung out of hot salt solution. Immediately the intestinal canal is opened, the exposed mucous membrane is cleansed by gentle swabbing with moist sponges.

Prevention of Hemorrhage.—The prevention of hemorrhage is accomplished by the proper application of the securing stitch, whether interrupted or continuous, the latter being the more reliably hemostatic. A perforating stitch of the Connell type is the best for securing hemostasis. If such a suture is not employed, the mucosa and submucosa in which the vessels lie should be secured by an additional continuous hemostatic suture.

Prevention of Gangrene.—In resection operations upon the intestine a study of the blood supply is necessary in order that the proper amount of intestine be resected. Before proceeding to a resection, it is well to hold up the loop to be resected and study the exact blood supply of that loop. It is better to resect a more considerable portion of the intestine and be assured of the blood supply than to resect an inconsiderable portion, leaving the blood supply doubtful. Sutures must not be so tightly applied as to constrict the tissues. Knots should be made small and flat so as not to cause pressure.

Needles.—Needles should be of 2 varieties: a straight round needle for use in all localities in which it can be handled, a curved round needle for such localities as will not allow of the application of a straight needle. The advantage of a straight needle is that it does not require a needle holder. A thimble may be employed if desired. The diameter of the needle should be that of a No. 6, 7 or 8 ordinary cambric needle; the length about 1½ to 2 in. Whether straight or curved, there must be no cutting edge and no great difference in the diameter of the needle.

Materials for Intestinal Sutures.—Fine braided silk, either plain or paraffined, and Pagenstecher thread are the materials most frequently employed. Catgut, either plain or chromicised, is used for a hemostatic stitch of the mucous membrane; it is not, however, to be relied upon as a securing suture. Of these materials, paraffined silk is personally preferred on account of its smoothness and pliability, and its consequently slighter capillarity and slighter liability to become tangled. Many prefer Pagenstecher thread for those sutures which do not penetrate mucous membrane; for those which do, very fine plain catgut. Whatever material is used, it should be of the same diameter as the needle employed, or, reversely, the needle employed should never be larger in diameter than the suture. The more closely the suture fills the needle hole the less the capillarity. In regard to the capillarity of through-and-through sutures, Connell (7) conducted a series of experiments from which he concludes that twisted silk has the greatest capillarity, linen and braided silk have much less, while Pagenstecher and catgut have still less. His experiments show that the fear of capillarity in through-and-through intestinal sutures is practically groundless, and that this objection cannot be sustained against them. Any suture that enters the lumen of the bowel or comes in contact with the mucosa should be non-absorbable; it is permissible, however, to use an additional suture of absorbable material for the purpose of hemostasis alone.

Preparation of Sutures.—These may be prepared according to the Willard Bartlett method (p. 362) or the Halsted method. The latter consists in threading a number of No. 6 to 8 ordinary cambric needles with the suture material in 14 in. lengths, 2 in. being allowed for the short side and 12 in. for the long. A number of these sutures are prepared and loosely sewed lengthwise through a towel, so as to admit of ready removal. The towel is rolled up ready to be sterilized when required.

Fate of Intestinal Sutures.—Absorbable sutures rapidly disintegrate when exposed on the mucous membrane. Non-absorbable sutures are cast off in their entirety through the lumen of the bowel when they pierce the interior or where they become exposed on the mucous membrane during the healing process; otherwise they remain in situ.

Principles of Suturing.—The submucosa must be included in the stitch to secure firm holding of the suture line. This necessarily implies a complete perforation of the gut by many if not all of the sutures passed. It has been proved that such a procedure is not dangerous, providing the suture is not so tightly placed as to cause strangulation of the tissues. Whether or not a second outer suture of the serosa and muscular layer is used depends upon the operator's confidence in his ability to **properly place and secure** the first-mentioned suture. The placing of a second or outer row undoubtedly adds to the safety of the anastomosis so far as leakage is concerned.

In end-to-end anastomosis there is a decided objection to the second or outer layer in that it still further narrows the lumen of the intestine already narrowed by a little less than $\frac{1}{4}$ in. all around by the proper placing of the securing sutures. **In lateral anastomosis this objection does not obtain, as the anastomotic opening makes up for any narrowing of the caliber of the bowel at the site of the anastomosis. We may, therefore, conclude that, for any except the most expert, lateral anastomosis with 2 layers of suturing is far safer than end-to-end anastomosis with 1 layer, as well as being the least calculated to result in narrowing of the lumen.**

The element of time consumed in either procedure should not be considered, for, if the patient's condition is not sufficiently good to permit of a formal anastomosis consuming 15 to 20 minutes, his condition is not good enough to permit of any but an emergency, temporary enterostomy, with a later formal operation.

Intestinal Suturing.—The oldest intestinal suture, or **Suture of the Four Masters** (so called by the Venetian School, 1520), consisted essentially of suture of the wound edges as in suture of the skin, the intestinal tube being steadied by the introduction of a cardboard cylinder or the trachea of a goose or calf. An improvement, made in 1846, consisted in cutting away the projecting edge of the mucous membrane (Duverger), so as to avoid prolapse of the latter into the suture line. The unstable character of this suture led to a search for a suture which would bring broader surfaces in contact. This was possible only by including in the suture the serous covering of the bowel. Such a suture was introduced in 1826 by Lembert, who took advantage of the knowledge possessed by the older surgeons. The principle of the Lembert suture in including serosorous approximation is to-day the most important feature of enterorrhaphy. It is now applied in such a manner that the needle enters the serosa at about $\frac{1}{4}$ in. from the wound edge, includes the entire thickness of the bowel except the mucosa, and emerges at $\frac{1}{8}$ in. from its point of entrance (Fig. 8). This is repeated on the opposite side of the wound, the needle entering at about ⅛ in. from the edge of the wound and emerging ⅛ in. from the point of entrance. The stitches are placed about ⅛ in. apart. They may be interrupted, as originally applied, or the continuous suture may be used. The weak point of the Lembert suture is the fact that the loop which grasps the intestinal wall and the line of traction of the suture pass practically in the same direction as the blood-vessels and circular muscular fibers, the thread thereby meeting with comparatively slight resistance in cutting its way out when tension is applied. In order to increase this resistance, the continuous Lembert suture should be applied in such a manner that the loop of thread corresponds to the long axis of the gut.

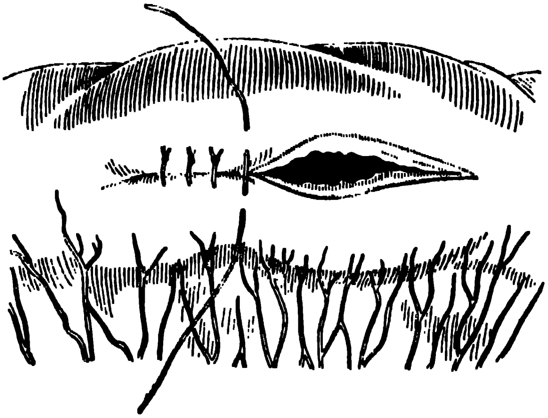

FIG. 8.—LEMBERT SUTURE.

CZERNY SUTURE. This method consists of first placing a row of interrupted sutures embracing all the coats of the bowel and securing the cut edges. Following this, a Lembert suture is placed (Czerny-Lembert).

PERFORATING SUTURES.—Samuel D. Gross, in 1843, and W. S. Halsted, in 1887, showed that no intestinal suture was safe unless all or a portion of the submucosa was included in its grasp. As the submucosa of the small intestine is only 1/6 the thickness of the cambric needle ordinarily used in intestinal anastomosis, the impossibility of securing the submucosa without piercing it entirely is readily seen. To make a secure anastomosis, therefore, it is necessary to penetrate all of the layers of the intestine. That this can be done safely has been amply proved by many operators.

The simplest method of applying a perforating intestinal suture is to approximate the serous surfaces to each other near the open ends of the gut and apply a row of interrupted mattress sutures from the interior of the intestine, including all its coats (Fig. 9). These sutures are knotted inside—Connell's method, interrupted. In order to secure this line of sutures, when the row is nearly completed, the last 1 or 2 sutures are passed in the same direction as the others, that is, so as to bring their knots inside. These ends are now threaded on a needle and the latter passed, eye first, between 2 sutures on the opposite side of the bowel. The suture is now tied, the knot readily slipping into place. In order to insure contact of corresponding points of the intestine, the suture is first applied at the mesenteric attachment and the ends temporarily left long for convenience, when the parts are steadied by an assistant. A second suture is applied at the convexity of the bowel directly opposite the first. In this way the circumference of the bowel is divided into equal parts.

The history of the use of perforating sutures for intestinal work dates back as far as Heister, in 1724. Jobert, in 1826, Gely, in 1842, Vezien, in 1871, Nussbaum, in 1882, Bishop, in 1885, M. E. Connell, in 1892, and Maunsell, in 1892, advocated the use of perforating stitches. The method did not, however, acquire popular recognition until 1903, when F. G. Connell published his method. Horsley, in 1903 and also in 1905, applied the method of perforating sutures, using a single row of overhand continuous suture. Willard Bartlett, in 1910, simplified the application of the Connell suture and proved the safety of tying the final knot on the serosa of the bowel.

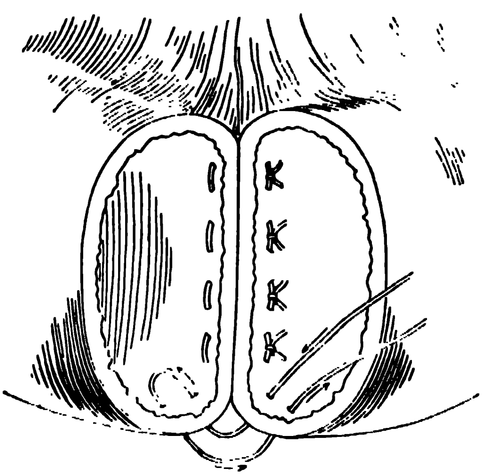

FIG. 9.—CONNELL'S METHOD OF END-TO-END ANASTOMOSIS (INTERRUPTED SUTURE).

In *securing a continuous suture* tied on the peritoneal surface it is desirable that the knot lies flat and that the last stitch does not pucker. To accomplish this, the short end of the thread is drawn through the needle to an extent equal to two-thirds of the remaining portion of the thread before the last stitch is taken; the last stitch having been taken, the double portion held by the eye of the needle is tied to the part of the thread not drawn through. In this manner a flat square knot can be tied without puckering.

CHOICE BETWEEN A CONTINUOUS SUTURE AND AN INTERRUPTED SUTURE.—The continuous suture is preferable both on account of its hemostatic properties and the time saved in its application.

The Avoidance of Contraction of the Opening.—If broad approximation of the peritoneal surface is insisted upon, there must necessarily be some contraction of the lumen in end-to-end anastomosis. If a narrow approximation of the peritoneum only is done, there is danger of wound separation before intestinal healing is effected. It is for this reason that the utmost skill must be exercised in the placing of each suture carefully, so that the minimum amount of peritoneal approximation may be made, in order to avoid undue contraction of the wound. If the operator is in doubt as to his ability to make an anastomosis of this type, it is far better to do a lateral anastomosis, in which latter broad areas of peritoneum may be approximated without danger of narrowing the lumen too much. The size of the primary opening in the lateral anastomosis should be made at least twice as large as is finally expected, to allow for contraction. Circular wounds tend to contract. This contraction may be prevented in part by accurate apposition of the various layers of the intestine, that is, the separate suturing of the peritoneal coat, of the muscular and submucous coat and of the mucous coat. This is not so readily accomplished in end-to-end anastomosis, though quite simple in lateral anastomosis. Ruth (29) has advocated the use of rubber dam over half of the suture line. This strip of rubber dam is ½ in. in width and of a length to cover half the area to be sutured. It is placed and held in position over the half of the suture already applied, by sutures of silk, linen or catgut.

In end-to-end anastomosis good seroserous approximation may be obtained by sectioning the intestine obliquely, as in Horsley's method (16), in place of directly across. Oblique sectioning provides a larger aperture to be sutured, with consequent greater provision for contraction.

Healing of Intestinal Wounds.—Intestinal wounds are supported for the first 3 days by sutures; from the third to the fifth day, during which time the wounds are weakest, the sutures loosen somewhat and the parts are held together by weak union; from the fifth day on, the union is firmer, until by the ninth day it is complete. During this period no cathartics should be administered which may act in a forceful manner on the musculature of the intestine.

Drainage in Intestinal Anastomosis.—If there is doubt as to the security of the suture, the intestine in question should be placed in the neighborhood of the wound and a drain led down near it. The drain should not, however, come in contact with the actual site of the suture, as by so doing it might interfere with the healing process. Cigarette drains are useful, or green silk protective rolled up in a bundle. The latter acts as a telltale, and in case of leakage is replaced by a tube drain.

INDICATIONS FOR OPERATIONS IN INTRA-ABDOMINAL INJURIES

Laparotomy should be performed as soon as a suspicion of intra-abdominal injury is entertained. From the moment that the patient has received the injury the pulse should be taken every half hour; a rising pulse-rate indicates an intra-abdominal lesion, and an operation should be done. It is better to open the abdomen on suspicion and find no lesion than to delay matters until the lesion has produced disastrous results. On opening the abdomen in recent injury the nature of the lesion may be shown by the escape of gas in the case of rupture of the intestine, by the presence of a large quantity of blood in rupture of the mesentery or omentum, and by the presence of bile or stomach contents in the case of injury to the gall-bladder or stomach. **If considerable time has elapsed since the receipt of the injury peritonitis will be well under way.** The advisability of operating upon such cases is questionable. It is the consensus of opinion that unless the operation can be performed within a few hours of the receipt of the injury interference is contra-indicated. In such cases, absolute rest in the elevated head and trunk position with a glass tube introduced into the pelvis through a suprapubic stab wound, in the hope that the peritonitis may subside or may become localized with or without abscess formation, and the drainage of such wounds as exist, in the hope that they may serve to lead away infectious extravasation, together with the usual means of combating peritonitis, fulfil all the indications.

ENTEROTOMY FOR THE REMOVAL OF FOREIGN BODIES FROM THE INTESTINE

Choice of an Incision.—If the foreign body is of a size that can be removed through a longitudinal incision on the convexity of the gut, of a length the closure of which can be effected without kinking the gut in a direction transverse to that in which it was made in such a manner as not to narrow the gut, then such an incision is indicated. If, however, the foreign body is of large size a transverse incision is preferable.

Location of the Foreign Body.—Foreign bodies which enter the intestinal canal by way of the stomach, should they pass the pylorus, are quite apt to traverse the small intestine without causing further trouble. If arrested at all they are caught in the lower portion of the ileum. Foreign bodies entering from the gall-bladder, if arrested at all, usually find lodgment in the lower part of the ileum.

Complications Following Enterotomy for Foreign Bodies.—D. Allessandro reports 2 cases, 1 death and 1 recovery, complicated by an intestinal worm escaping through the recently sutured intestinal wound.

OPERATIONS FOR PERFORATION OF THE SMALL INTESTINE

A right rectus incision is made either above or below the umbilicus, according as the signs indicate. Evidence of peritonitis will be met with as soon as the abdominal cavity is opened. Tracing these evidences by their increasing severity will indicate the site of the lesion. The characters of the peritoneal exudate, also, often furnish valuable information as to the site of the perforation. Free fluid is rapidly sponged up or sucked up, and the site of perforation isolated by laparotomy sponges. Usually as the perforation itself is approached, there will be a fresh gush of fluid. This is due to the separation of the slight adhesions which nature has set around the perforation.

In the case of a **duodenal** perforation the liver may cover the perforation, or the omentum may be rolled up and cover it. In either event the parts are well separated, the operative field isolated by laparotomy sponges, and the local operation proceeded with. In the case of duodenal perforation the colon is held downward by a laparotomy pad, the stomach is held toward the median line by another pad, while any invasion of the small intestine is controlled by pads and hand pressure by an assistant. The liver is retracted upward and outward by a broad retractor. The duodenum is freed from adhesions; if this is not done, great difficulty will be found in closing the perforation if it is possible to close it at all. Perforations of the duodenum usually occur in the first portion. These are quite accessible to treatment, though difficulty is met with in the suturing, on account of the induration of the edges of the perforation. Failure to free the intestine from the neighboring structures is a cause of failure of union (Murphy). The closure of the perforation is governed by the same principles and the same methods as those discussed under enterorrhaphy, with the additional difficulty presented by the induration of the edges of the ulcer. If it is found that the sutures will not hold on account of the induration, it is best to excise a portion of the indurated area and then suture. If possible, the sutures should be so placed as to avoid narrowing of the gut as much as possible. Two lines of sutures should be employed so as to infold the perforation. Direct suture of the edges of the perforation will usually fail. The first layer of sutures should be placed at a slight distance from the edge of the perforation, the second layer still further away. In most cases this will result in a decided narrowing of the duodenum. The suture line is further strengthened by bringing up a piece of omentum and attaching it over the suture line. In cases which will stand the shock of the additional procedure a posterior gastro-enterostomy should be done, while in cases which cannot stand this a jejunostomy should supplement the plastic operation upon the duodenum.

The after-treatment consists in keeping the stomach empty; in the case of gastro-enterostomy feeding for a few days by rectum, and in the case of jejunostomy feeding by the jejunostomy tube should be carried out for a sufficient length of time, 8 or 9 days, to allow healing of the duodenal opening. Drainage should be used, though the drain must not touch the line of suture but be in its neighborhood. A green silk-covered cigarette drain of gauze or lamp wicking is preferable. In complicating diffuse septic peritonitis cases, the patient is placed in the elevated head and trunk position with a glass tube in the pelvis emerging from a suprapubic stab wound. If aspirating suction has been properly used pelvic drainage will not be necessary.

If it is found that the ulcer is so friable that even after its edges have been trimmed it is impossible to suture it, a diamond-shaped section of the duodenum, including the ulcerated area, should be removed and the resulting wound sutured transversely to the long axis of the gut. Should the perforation be in the second portion on the posterior surface, which is rare, mobilization of the duodenum must be practiced and free exposure of the opening made. Such cases present more difficulty than ulcers perforating on the anterior surface and require more extensive drainage.

Perforating Typhoid Ulcer.—As the perforation is usually in the last few feet of the ileum (81.4 per cent. of cases, according to Keen) a right rectus incision below the umbilicus is the incision of choice. The ileocecal juncture is identified, and the ileum traced upward to the site of perforation. Keen's statistics show that 16.7 per cent. of these cases have multiple perforations, so that, having found 1 perforation, others should be looked for. The perforation is treated according to the methods cited in enterorrhaphy. The friability of the intestine in typhoid cases makes the operation more difficult, while the condition of the patient is such that a prolonged operation is contra-indicated. Should multiple perforations exist within a few inches of each other, the affected loop should be excised and an end-to-end anastomosis done by Murphy button. Should the condition be such as to contra-indicate even this simple procedure, an artificial anus should be made.

Enterorrhaphy in Wounds of the Intestine.—The technic of enterorrhaphy depends upon the site and character of the wound. The 3 principles to be carried out are the secure apposition of the wound, the preservation of the proper lumen of the bowel, and the covering of all raw surfaces. In lacerations involving the peritoneal coat alone, it is sufficient to draw the peritoneum over the raw surface. If this cannot be accomplished by direct union, the raw surface can be covered by omental graft or by raising a peritoneal flap from the mesentery and covering the defect with it as advocated by Richardson. The purpose of this method is to cover the denuded area with a layer of peritoneum taken from the adjacent mesentery. An incision is made in the peritoneal covering of the mesentery about 1 cm. from its bowel attachment, in order to avoid the numerous branching vessels in this region. The incision is slightly longer than the area to be covered. The peritoneal flap is easily and safely separated by blunt dissection to any desired extent. This flap is drawn upward over the raw bowel surface and there fixed by interrupted sutures of silk. Owing to the mobility of both the bowel and its mesentery, it is claimed that no harmful effect is produced. The angles of the mesenteric flap just at the bowel margin are closed by suture. Should the mesentery be so deficient in fat as not to allow of safe separation of its layers without probable injury to the blood supply, both leaves are grasped together at a proper distance from the bowel border, lifted on the raw surface, and fixed by silk sutures, care being taken to place the sutures between the vascular trunks. A possible objection to this method is that intestinal obstruction might be caused by what Cheyne and Burghardt describe as a rolled up kink due to inflammatory adhesions. The symptoms of such an obstruction are usually chronic in character. The method has not been sufficiently used to recommend it as a routine measure, but its use in an emergency is permissible.

If the peritoneal and muscular coats are injured, suturing is sufficient irrespective of the site or extent of the wound and irrespective of the blood supply. In case of laceration of all the coats suturing will suffice for small perforations and linear tears; in larger perforations various plastic procedures are indicated, while if a tear of the gut involves the blood supply, a resection may be necessary, depending upon the amount of intestine damaged. In suturing irregular wounds with lacerated edges, the lacerated and contused edges should be excised. Intestinal wounds transverse to the blood supply are sutured in the line of the blood supply, that is, the reverse of the direction in which they were made. Wounds parallel to the blood supply are sutured in the same direction as that in which they were made. Wounds made by cutting instruments do not, as a rule, require trimming, while wounds resulting from contusions do, as they are usually lacerated. Irregular shaped wounds should be converted into regular shaped wounds by trimming the edges and should be sutured according to the direction of the blood supply.

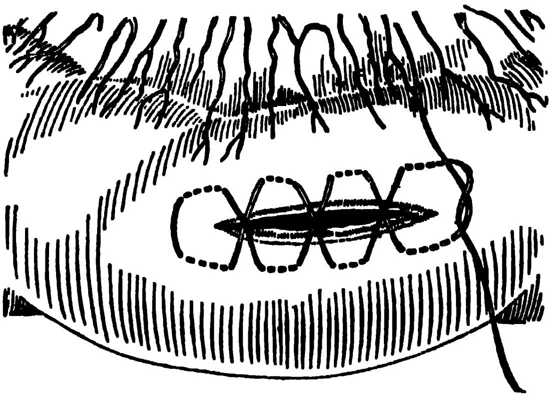

Fig. 10.—Gelly's Suture.

If the perforation is small, no matter in what part of the intestine it is located, it may be repaired by a single purse-string suture. If slightly larger, the purse-string suture may be reinforced by a few Lembert sutures placed parallel with the blood supply. For small longitudinal incisions the Gelly suture is useful (Fig. 10). When the wound is larger or irregular in shape, the purse-string suture results in too great a narrowing of the caliber of the bowel. In such a case the edges of the perforation are trimmed so as to make a diamond-shaped opening, and the wound is sutured parallel with the blood supply. Wounds of the convexity and across the blood supply are secured by 2 layers of sutures, 1 including the entire thickness and inverting its edges as far as possible, such as the Gelly suture. This layer is reinforced by a continuous Lembert suture. Should the mesenteric border be involved, the tear of the mesentery should be enlarged sufficiently to expose the wound, and this portion of the gut should be sutured first by inserting a mattress suture at the mesenteric site tied within the bowel. This suture should be so placed, even if it is necessary to enlarge the wound in the intestine somewhat, as it is at this point that leaks are most likely to occur; the remainder of the wound is then sutured in the direction of the blood supply; the mesentery is sutured last. Should the wound be a transverse one involving ⅔ of the diameter of the gut, the placing of guy sutures and the union of the edges of the wound with a Connell suture will be found the most practical. In this class of wounds, if there is much narrowing, a lateral anastomosis should be done in addition in the neighborhood of the intestinal wound. Should the wound of the bowel be lacerated and involve more than half the circumference, a resection is indicated followed by end-to-end or lateral anastomosis. If, following plastic operations involving large defects in the bowel, it is found that there is much kinking at the site of the suture, a lateral anastomosis should be done. In all wounds of the character just described, a continuous suture is preferable to an interrupted suture, but in this class of wounds even more than in wounds made by operation it is necessary that a good grasp on the tissues be made, particularly as the centers of wounds which are transverse to the blood supply present considerable tension when sutured. When the intestinal wall is very friable, mattress sutures should be used, either interrupted or of the type known as the Connell suture. When 2 large perforations on either arm of a loop are present, lateral anastomosis may be made by means of these openings instead of repairing each; loops at a distance, however, should not be laterally anastomosed in this manner, as functional disturbances may follow. If the condition of the patient is such as not to allow of the repair of a large perforation, a neighboring loop of intestine may be sutured against the perforation (Lejars) so that the peritoneal coat takes the place of the mucous lining, thus imitating nature's method. In multiple injuries close together a resection is indicated.

In cases in which the mesentery is torn entirely loose from the intestine for a distance of several inches, resection is indicated. At times, however, in emergency cases in which to resect would be sufficient to cause the immediate collapse of the patient, the mesentery may be sutured in place and the loop of affected intestine surrounded with omentum. This method has proved effectual in at least one case.

Omental Grafts.—To further safeguard against perforation following suture of the intestine, the elder Senn advocated the use of pieces of omentum, preferably torn from the omentum, placed against the suture line. This method is not to be relied upon alone, but only as an additional safeguard. In certain cases in which it is not possible to suture the defect securely the method is worthy of consideration. In Senn's experiments the intestinal peritoneum was slightly scarified before the graft was sutured in place.

Results Following Operations for Injuries to the Intestine.—Recovery is the rule if the operation has been done in the first 4 hours. Death occurs from hemorrhage or peritonitis, complications which existed before the operation and which are rapidly fatal. Failure of union in an intestinal wound, with consequent perforation, may occur from the third to the fifth day. Focal abscess may occur due to failure of intestinal union. With the occurrence of this in view, it is well to maintain drainage for 7 days in cases where there is doubt as to the security of the suturing or the viability of the intestinal wall. Intestinal fistulæ forming in the drainage tract tend to close spontaneously. Should an artificial anus result, this will call for surgical intervention.

OPERATIONS ON THE DUODENUM

Operations upon the duodenum include resection of the duodenum for duodenal ulcer; anastomosis operations upon the duodenum; duodenojejunal anastomosis. Jaboulay, in 1892, anastomosed the jejunum, below the gastrojejunal anastomosis, with the third portion of the duodenum, in an attempt to prevent the discharge of the duodenal secretions into the stomach. These operations are described in connection with gastro-enterostomy.

Mobilization of the Duodenum.—See Localization of the Duodenum.

Duodenostomy.—Incision into the duodenum for the purpose of exposing the common bile-duct or the duct of Wirsung is treated in the surgery of the gall passages and pancreas. Duodenostomy was first proposed by Braune. Von Langenbuch was the first to perform the operation (Kocher). Hartman prefers the operation to jejunostomy (Kocher). It is possible by mobilization of the duodenum to bring it into the abdominal wound without tension. Jejunostomy is so much simpler, however, that duodenostomy is rarely, if ever, indicated. The chief objection to duodenostomy, aside from its more elaborate technic, is the difficulty of keeping the biliary and pancreatic secretions from escaping through the fistula.

JEJUNOSTOMY

This operation was employed by Surmay in 1878. Karewski, in 1896, adapted the method of Witzel's gastrostomy to jejunostomy.

Indications.—Jejunostomy is indicated in inoperable stricture of the pylorus with advanced carcinoma of the stomach, i. e., cases in which a gastro-enterostomy is not possible; in carcinoma of the cardia; in contracted stomach; preliminary to extensive stomach resection in weakened patients; preliminary to extensive operations upon the esophagus; to take the place of gastro-enterostomy following plastic operations in the neighborhood of the pylorus; as a substitute for gastro-enterostomy in perforating ulcers in the neighborhood of the pylorus following repair of the perforation; in ulcers of the stomach which do not permit or excision; in all cases in which it is wished to give temporary or permanent rest to the stomach and at the same time maintain nutrition; and in esophageal carcinoma. This operation will probably come to be recognized as the best treatment for ulcers of the stomach outside the pyloric area and not admitting of excision, in that almost complete rest can be given to that organ and at the same time perfect nutrition of the patient be maintained.

Mayo's Method.—The abdomen is opened by an epigastric incision in the midline or to the left, through the rectus muscle. The jejunum is drawn up and a point selected from 12 to 16 in. from its origin, where a small cut is made on the convex surface and a No. 9 (English scale) rubber catheter pushed through the opening in a downward direction until it extends 3 in. inside the lumen of the gut. The catheter is fixed in this position by a single chromic gut suture piercing the edge of the minute incision and the wall but not the lumen of the catheter. Slight pressure on the catheter inverts the opening somewhat. Beginning at a point below the jejunal opening, the jejunal wall is infolded over the catheter for 1 or 1½ in., using mattress sutures of linen. The infolding of the catheter is done in the same manner that a Witzel operation is done upon the stomach (Fig. 11). The intestine is anchored to the peritoneum by 2 or 3 linen sutures in the lower angle of the abdominal incision, which is closed down to the tube in the usual manner, or the end of the catheter can be brought out through a small stab wound at one side of the incision, the intestine being fixed to the peritoneum by several linen sutures.

Maydl's Method.—An incision is made to the left of the umbilicus through the fascia of the rectus. The muscle is retracted, and the incision carried through the peritoneum. The jejunum is identified and brought into the wound. It is sectioned between 2 clamps, 20 to 25 cm. from its commencement. The mesentery is split and the cut end of the upper segment of the intestine implanted, 10 to 15 cm. from the point of division, into the lower segment, as in Roux's Y method of gastro-enterostomy. The cut end of the lower portion is fixed to the skin by interrupted sutures; the entire thickness of the gut is included in the suture. The abdominal wound is closed, taking care not to constrict the intestine.

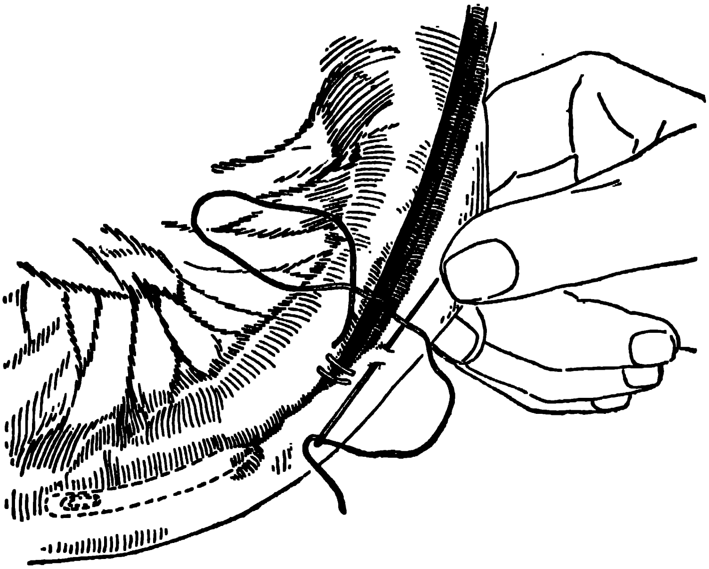

FIG. 11.—MAYO'S METHOD OF JEJUNOSTOMY.

The *advantage* of this method is that, in place of the small fistula through which feeding is done through a small caliber tube, there is a large opening which admits a large tube through which the patient can feed himself, after having chewed the food. A further advantage is that the tube does not have to be worn constantly and that while in the Mayo operation the slipping out of the tube means that it must be replaced quickly in order to avoid closing of the peritoneal tract, in the Maydl operation no attention need be paid to the tract, as it cannot close. The *disadvantage* is that there is some escape of mucus which requires attention. A further disadvantage is that this is a more serious operation than the simple method of Mayo.

Choice of Procedure.—The indications for the two procedures may be defined as follows: The Mayo operation is indicated in patients of extremely low vitality in whom a more complicated procedure might prove fatal, as well as in cases in whom the feeding is to be but temporary. The Maydl operation, on the other hand, is indicated where the patient is in condition to stand this more complicated procedure and in whom the feeding by this method is to be permanent.

Complications of Simple Jejunostomy.—No subsequent ill effects from the jejunum remaining adherent to the peritoneum after removal of the feeding tube have been observed. The mortality of the operation is negligible. Kinking of the proximal loop at the duodenojejunal juncture is possible if the loop is too short, thus putting the intestine on the stretch. Kinking might also result from this cause at the parietal attachment of the gut. If too large quantities of fluid are given at first, some discomfort following the feeding will be complained of.

After-treatment.—Following the Mayo method, the tube **must be kept in place.** If it slips out it **must be replaced** within a very short period, or the peritoneal tract will have become obliterated. After the indications for jejunal feeding have passed and removal of the tube is indicated, simple removal of the tube will quickly be followed by closure of the fistulous tract. Leakage does not follow the removal of the tube. If the Maydl method is used, the tube is only introduced at feeding times. Small quantities of fluid nourishment may be given through the tube as soon as anesthetic nausea has passed off, or even before in much emaciated patients. Any kind of nutritious material which can be made fluid enough to go through the tube may be used. The quantity introduced at first should be small and given at frequent intervals; later larger quantities at more extended intervals may be used. At first it is well to predigest the food. At all times the injected material should be warmed to blood heat. Before and after feeding the tube should be flushed with a small quantity of saline or plain water to keep its lumen clean. The improvement in nutrition is remarkable in cases treated in this way. These patients can be taught to feed themselves. The diet should be mixed; a little ingenuity will provide a sufficient variety. In inoperable carcinoma cases the tube is employed indefinitely; in ulcer cases for from 6 to 8 weeks. In one of my cases, an enormous ulcer, the tube was retained for 6 months, during which time, except for the initial 4 weeks, the patient performed out-of-door work. The fistula closed 3 days after the removal of the tube and remained closed. One year later the man was perfectly well.

Results of Jejunostomy.—Of 68 cases operated upon by von Eiselsberg, 51 per cent. died in the first month; 32½ per cent. died shortly following the operation from collapse, peritonitis, hemorrhage, or pneumonia. In carcinoma cases life is prolonged for an average of 3 months, the condition of these patients is greatly ameliorated, and there is considerably less pain. In ulcer of the stomach this operation is in many cases curative. Rest to the ulcerated area is assured as long as the patient follows instructions and feeding by jejunum is continued.

In my hands it has proved of inestimable benefit, not only in extensive ulcerations of the stomach of a non-malignant character, but also in cases of otherwise inoperable carcinoma. It is only a matter of time when the value of this operation will be more generally recognized and it will be far more frequently used in the treatment of ulcer of the stomach. Compared to the ordinary treatment by rectal feeding, it is so far superior that its merits must appeal to the medical practitioner; whereas the ordinary medical treatment of ulcer of the stomach keeps the patient from pursuing his occupation, jejunostomy allows him to continue his work after a short interval of rest and at the same time maintains his nutrition.

ENTEROSTOMY

Indications.—Enterostomy is indicated as a temporary expedient in cases of intestinal obstruction too far gone to permit of a radical procedure. In not a few cases in which a complete obstruction has supervened on an incomplete obstruction enterostomy has of itself proved curative. It is also indicated in cases in which a radical procedure has been carried out, but in which it is also desirable to temporarily drain the intestine of its putrid contents above the site of obstruction. In the former, i. e. when enterostomy alone is performed, the procedure is as follows:

Simple Enterostomy.—Under local anesthesia an incision is made in the lower right quadrant. The peritoneum is only opened sufficiently to admit 2 fingers; through this opening the forefinger is introduced over the psoas and iliac muscles into the pelvis, and the terminal ileum is located. If this is not feasible, a distended loop of gut lying external to the wound is seized by its convex border and drawn into the wound; this is done without altering the natural position of the gut. Several methods may be used in fixing the gut in the abdominal wound. The adjoining portions of the loop may be stitched together on either side so as to form a spur which can later be destroyed by a Dupuytren's enterotome, thus restoring the continuity of the gut when the indication for the artificial anus has passed. Stitching the 2 legs of the loop together in this manner precludes the possibility of another intestinal coil becoming adherent at the site where it may be necessary later to use an enterotome. It is best to stitch the peritoneal surfaces together for 3 or 4 in. The gut is now adjusted in the wound, the surplus portion being returned to the abdomen so that the convex surface of the gut is slightly above the level of the skin. If the wound in the peritoneum has been made of the proper size, it will now encircle the neck of the prolapsed gut snugly but not tightly enough to constrict it. With catgut the peritoneum is attached to the loop at several points. These sutures should include the transversalis aponeurosis and, if necessary, a portion of muscle, in order that the loop may be held securely fixed in the wound. Care must be taken, in passing the sutures securing the intestine to the peritoneum, not to enter the lumen of the intestine. The convex portion of the loop is attached to the skin on either side with silk. These sutures are left untied for the present. The wound is now closed up to the convex surface of the gut. Several additional sutures are placed to hold the convex surface in apposition with the skin, and these and the first sutures of this character are tied. A purse-string of silk is now placed on the convex border; in the center of the area surrounded by the purse-string an incision is made with a scalpel. Through this incision a Mixter or Paul tube of small caliber is passed, and the purse-string tied to secure it in place. As the contents of the small intestine are liquid, it is not necessary to use a large tube. A large rubber catheter with inversion of the opening in the gut fulfils the purpose admirably. The tube should not project for any great distance into the interior of the gut unless one is sure which is the afferent portion of the loop, in which event the tube may be inserted in that direction. Performed in this manner, there is little danger of soiling the wound. Sponges are placed to catch what intestinal contents escape during the short interval between making the intestinal incision and introducing the tube.

If the peritoneal incision has been large, it should be sewed up to the neck of the intestinal loop before performing the above procedure. In introducing the glass tube or catheter the cut in the intestine is held open by an assistant grasping it at 2 points, while the operator grasps the margin at a third point, making a triangle, thus facilitating the introduction of the tube. By making the abdominal incision in the ileocecal region, one is fairly positive of securing a loop of the lower ileum in the neighborhood of the ileocecal valve.

If, in the course of exploratory laparotomy for obstruction through a rectus incision, it is deemed best to use the temporary expedient of enterostomy, the enterostomy had best be performed through an additional incision as described. As time is an element to consider in these cases, an assistant should perform such portions of the operation as can be simultaneously done without interference with the operator. Before incising the gut the line of the incision, as well as the line of juncture with the skin, should be painted with Woelfler's solution or collodion to avoid contamination. That portion of the suturing which unites the intestine to the skin must be done with a fine cutting edge needle, a round needle not being adapted to this purpose. The loop of gut selected should lie in the wound without tension.

Enterostomy in the small intestine is an emergency operation, and as a rule is performed only in those cases in which any but the simplest procedure would of itself prove fatal.

DANGERS OF THE OPERATION.—Performed under local anesthesia the procedure as outlined, if not accompanied by exploration, is practically without danger. Cases apparently moribund do not seem to receive any additional shock from the procedure. If an exploration, however, is added to the procedure, a very appreciable amount of shock will be noted. In cases of intestinal paresis the operation will be ineffectual, as only the loop incised will be drained. Even in such cases, however, the use of atropin sulphate in large doses, repeated to the point of paralysis of the bladder, will in some cases enable the small intestine to expel its contents.

RESULTS.—The value of this operation was shown many years ago by Treves, and by its use the mortality in acute intestinal obstruction has been reduced 50 per cent. To achieve such results, however, extended exploration and the exposure of peritoneal surfaces must not be indulged in. The enterostomy must be performed in the simplest and quickest manner. Its purpose is to free the intestine of its noxious contents, **the absorption of which is the cause of death in acute intestinal obstruction.** In not a few instances the relief of the distention above the site of obstruction has a beneficial effect upon the cause of obstruction itself.

Later the artificial anus is closed when the need for its continuance no longer exists. Its closure is preceded, if indicated, by a formal operation upon the cause of the obstruction.

Enterostomy for the Purpose of Draining the Intestine Above the Site of Obstruction and Accompanied by a Simultaneous Enterectomy.—INDICATIONS.—Such an operation is indicated when the obstruction has been of long standing and of a nature, such as gangrene of the gut, which will not permit of simple enterostomy with subsequent treatment of the cause of obstruction.

TECHNIC OF OPERATION.—The gangrenous area is resected and a large rubber catheter or Mixter or Paul tube is inserted in the open end of the afferent loop, a purse-string suture is applied, the cut edges of the gut are inverted, and the purse-string tied down so that the gut grasps the tube tightly. The open end of the efferent loop is closed in the usual manner. A lateral anastomosis is now done, allowing several inches between the site of anastomosis and the end of the afferent loop. This completed, the end of the afferent loop is brought without tension through the abdominal wall, a wound being made for this purpose, where it is sutured to the parietal peritoneum and also to the skin. None of these sutures should enter the lumen of the gut. When the indications for the temporary enterostomy are passed, the catheter is withdrawn and the fistula allowed to close. Extensive inversion of the cut edges of the afferent loop around the catheter usually permits closure to occur readily. If this does not happen, the intestine is dissected free from the abdominal wall, still further inverted with purse-string sutures, and dropped back into the abdominal cavity. It is essential for the final success of the operation that the distance between the lateral anastomosis and the cut end of the afferent loop be sufficient for a plastic operation to readily effect closure of the fistula.

Enterostomy for Gangrene in Which the Conditions Will Not Allow of Anastomosis.—In such cases the gangrenous gut is brought entirely outside the abdomen, the healthy portions beyond the area of gangrene are sutured together as in simple enterostomy, and a healthy portion of the gut sutured to the skin, as in the same operation. The wound is closed up to the intestine and the gangrenous portion of gut is cut away. The bleeding from the cut intestinal edges is controlled. Later communication between the 2 loops is effected by a Dupuytren enterotome and a plastic operation done for closure of the fistula.

Complications of Enterostomy.—*Erythema* is controlled somewhat by a drying powder composed of carbonate of magnesia, zinc oxid, and talcum. *Erysipelas* is rare. *Phlegmon* is treated by proper drainage necessitating in some instances counter openings and removal of sutures.

Peritonitis rarely occurs except as the result of the condition for which the operation has been performed. In suitable cases it may be entirely prevented by delaying the opening of the artificial anus until time has elapsed, 24 to 48 hours, for the occurrence of adhesions in the neighborhood of the affected loop.

Hernia or eventration of intestine occurs rarely. *Prolapse* of the mucous membrane of the artificial anus, or even of all the layers of the artificial anus (*invagination*), may occur. The proximal portion of the loop is that usually affected. *Ulceration* may complicate prolonged prolapse. In cases in which it is necessary to maintain the artificial anus, eventration and prolapse can be cured by making an incision and suturing the affected limb of the artificial anus to the abdominal wall. This can be done without entering the peritoneal cavity, the finger within the intestinal loop serving as a guide for the introduction of the sutures, the abdominal wall being incised down to the parietal peritoneum, and the sutures there introduced. Care should be taken that the sutures do not enter the lumen of the gut.

Stricture.—The distal limb of the artificial anus always become smaller than normal. At times, through chronic inflammation or the extension of already existing disease, stricture results.

Neurasthenia.—In some patients the mental condition is influenced by the existence of an artificial anus.

After-treatment of Enterostomy. No attempt should be made to wash out the interior of the intestine. The tube draining the intestine should be connected to a receptacle; when the tube loosens after 4 or 5 days there will be an escape of fecal matter alongside of it. Upon the appearance of this the tube is removed and loose absorbent dressings applied, which are changed every hour or so. Care must be taken that the dressings are not applied in such a way as to interfere with drainage.

Following enterostomy for gangrene of the intestine, even if the operation itself is not severe, the patient will usually die of general debility or peritonitis in from 24 to 48 hours. The case has usually progressed too far before surgical measures are instituted. Done formally, the prognosis is good. The after-treatment is troublesome. The suture line and neighboring skin are painted with collodion or Woelfler's peritoneal varnish to prevent irritation. An abundant absorbent dressing of paper wool covers the wound; this is renewed every few hours. The wound in the neighborhood of an artificial anus is particularly liable to infection from the presence of the discharges. Immediately upon the appearance of infection the sutures should be removed. The infection may be deep-seated and not show at first, except through the temperature; in such cases the sutures are removed and the wound opened. This will present a nasty sloughing appearance. A moist antiseptic dressing hastens the separation of the sloughs.

Skin irritation may be prevented in part by anointing the skin in the neighborhood of the artificial anus with vaselin. A moist eczema is liable to develop and can only be kept in check by strict cleanliness. After a week or 10 days, when wound healing has become somewhat firm, the patient may be placed in a warm bath for ½ hour twice daily; this is a source of great comfort to the patient and cleanses the wound. The granulations in the neighborhood of an artificial anus are apt to become grayish owing to the discharge. This will necessitate stimulating dressings.

The sutures which are used to hold the intestine in position, as a rule, take care of themselves; they loosen and come away. The wound cicatrizes slowly; the mucous membrane of the gut proliferates, until finally cicatrization between it and the skin is complete.

The effect of an artificial anus upon the general health depends upon the portion of the intestine from which the anus was formed. If it is in the sigmoid, nutrition does not suffer; if in the cecum or the small intestine in the neighborhood of the ileocecal valve, nutrition is not markedly interfered with. It is to be borne in mind, however, that it is in the large intestine that absorption of fluid for the most part takes place. The higher up in the small intestine the fistula is placed, the more marked the inanition. If it is in the duodenum or jejunum, inanition rapidly follows and the patient dies of debility; if high up in the ileum, patients may live for some weeks or months. The treatment for fistula placed high up is early operation before the patient has become too much enfeebled. The site of the fistula can be determined by the character of the stools. The patient should be weighed daily, and if loss of weight is shown, operation should not be delayed. The diet should be highly nutritious and such as to leave the smallest possible residuum in the intestines. Soup, eggs, milk, farinaceous food, scraped beef, peptones, rice pudding, young chicken, and lamb form the best diet; this is supplemented by rectal alimentation. An attempt may also be made to place predigested foods in the efferent loop of the fistula. If this is possible, it not only nourishes the patient better, but prevents contraction of the portion of the bowel below the fistula. Reverse peristalsis tends to prevent feeding through the efferent loop. Spontaneous closure, while possible, should not be waited for, as in the meantime the patient is losing more and more strength. The only radical treatment is an early operation, either intra-abdominal or by Dupuytren's clamp and a subsequent plastic operation. After operating by means of Dupuytren's clamp, it will be necessary to quiet the pain with opium. It takes 6 or 8 days for the clamp to ulcerate through; in the meantime adhesions form which guard the peritoneal cavity against infection. If the attempt is successful, a *fecal fistula* results in place of the artificial anus, the fecal current for the most part passing along the channel made by the clamp. Such fistulæ have a tendency to close, but it is better to aid in their closure by a plastic operation.

Inability of the Artificial Anus to Functionate.—Occasionally it happens that while gas passes more or less freely through the tube usually left in the enterostomy opening at the time of operation, the passage of fecal matter does not occur. A condition of partial obstruction is present. This may be due to too much traction on the intestine, or too tight closure of the abdominal wound in an attempt to make an ideal anus, or to paresis of the loop operated upon. It is overcome by inserting the tube further into the gut and by the use of frequent enemas through the tube.

Closure of the Enterostomy Opening.—An enterostomy of the small intestine should be closed as soon as the indications for its use have passed. Early closure is particularly desirable as the contents of the small intestine are liquid and irritating and it is difficult to keep the patient clean. Moreover, the health suffers in proportion to the proximity of the opening to the duodenum. The essential point in the closure of these openings is the destruction of the spur. This can be accomplished by the use of the enterotome, or the loop, the site of the enterostomy, may be excised. If the enterostomy has been done in a typical manner, its closure can be effected by the use of a Dupuytren enterotome, supplemented, after the proper direction of the fecal current is established, by a plastic operation. To accomplish this, Dupuytren's enterotome is inserted, one blade into each leg of the enterostomy, in such a manner as to grasp the spur. The enterotome is then screwed down until it firmly compresses the spur. A turn or two of the screw is added each day until by the eighth or ninth day the instrument has cut its way entirely through the spur. A plastic operation may now be undertaken. Various modifications of the Dupuytren instrument have been made, all retaining the essential principle, but these have no distinct advantage over the original.

If the enterostomy has not been performed in a typical manner, there is a possibility that the enterotome may seize and crush a knuckle of gut adherent between the legs of the enterostomy. In such cases the following procedure is indicated: The enterostomy opening is packed with gauze to prevent soiling. One-half inch from the margin of the opening an incision is made through the skin, completely encircling the opening. The skin is dissected toward the opening, and the edges of the skin sewn together over and over in such a manner as to completely occlude the opening and thus prevent the possibility of soiling the site of operation. The incision is deepened through the peritoneum, taking care that the gut be not injured; the adhesions are separated and the loop, the site of the enterostomy, is drawn outside the abdomen. The abdominal cavity is protected by laparotomy pads, that portion of the bowel which is the site of the enterostomy is excised, and an end-to-end or lateral anastomosis done. If the opening is within a few inches of the ileocecal juncture, there may not be room for a satisfactory lateral anastomosis, so that an end-to-end anastomosis may be imperative. The various layers of the abdominal wound are now separated and sutured. Preliminary to this operation and to all plastic operations for the cure of artificial anus or fecal fistula, it is essential that the skin in the neighborhood be brought to as near the condition of normal as possible. This can only be accomplished by the most minute attention to cleanliness.

Closure of Fecal Fistula.—Most fecal fistulæ close spontaneously if the gut is not adherent to the skin. The closure is facilitated by the administration of foods which leave the smallest possible residue in the intestine, and by the administration of enemata twice daily to keep the lower bowel empty. If the fistula is situated high up on the intestine, its closure must be quickly effected or rapid inanition will result; if situated low down, a reasonable wait of 2 weeks is allowable. During this time the fistulous tract is frequently cleansed. If the discharge escapes by way of an abscess cavity, this should be opened up freely and frequently cleansed. Failing of spontaneous closure, a fecal fistula of the small intestine usually demands resection followed by an end-to-end or lateral anastomosis. Such cases will present great difficulties, and, where possible, they should be dealt with in the same manner as resection for enterostomy. Other cases can be dealt with by closing the external opening with sutures, as described in closure of enterostomy, and then opening the abdominal cavity at some distance from the site of the fistula and ascertaining the exact conditions intra-abdominally.

When the opening is situated high up in the intestinal canal and the condition of the patient is such that an operative procedure is contra-indicated, a temporary expedient of inserting a rubber tube, on the same principle as that employed by Kerr in draining the bile ducts, may be employed. In a personal case this simple device effected an absolutely mechanical closure and tided the patient over until sufficiently recuperated to withstand a formal operation. Nutrition was maintained through a small catheter inserted through a minute opening in the wall of the larger tube into the efferent intestine.

The operative treatment of persistent fecal fistula depends upon the type of fistula present. If the loop of intestine of such a fistula is adherent to the skin, the opening being of moderate size without prolapse of the posterior wall of the gut, closure is comparatively easy. The open fistulous tract is encircled by an incision, this external incision is securely sutured to prevent soiling, the tract is dissected down to the peritoneum, clamped at the level of the intestine, and amputated, the stump is disinfected and buried in much the same manner as is the stump of an appendix. If the fistula is of larger size, with prolapse of the posterior wall, much can be accomplished as regards the diminution of the caliber of the external opening by inserting a rubber tube of proper size into the long axis of the intestine to control the prolapse. When the external opening is diminished in size sufficiently, it is closed in the manner described above. If the prolapse of the posterior wall has existed for a sufficient length of time to allow of the agglutination of the mesentery, thus forming a spur, the use of a Dupuytren enterotome is indicated. If the fistula is long and tortuous, though of small size, temporary closure with sutures to avoid infection, followed by a laparotomy to identify the portion of gut which is the site of the fistula, is indicated. The site of the opening of the fistula into the intestine is identified, clamped, disinfected, and inverted in the same manner as the stump of the appendix. No attempt should be made to close a fistula which communicates with a cancerous portion of the bowel. Lateral anastomosis, with or without exclusion of the cancerous loop from the remainder of the intestine, may be done if the discomfort from the fistula is too great.

Intraperitoneal fistulæ require more extensive operation, including the closure of the organ with which communication has been established.

If for any reason it is deemed desirable to maintain the artificial anus or a fecal fistula, provision must be made for keeping the patient as clean and comfortable as possible. In the case of the large intestine, this is more readily accomplished by reason of the nature of the intestinal contents than in the small intestine. Even here, however, a comparative degree of comfort is attainable by the use of a cup-shaped apparatus with a container attached, such as is exemplified by Delatour's colostomy cup.

ENTERECTOMY

Indications.—Enterectomy is indicated in contusions and wounds by firearms. (In such cases the prognosis is favorable if operation is performed within the first 6 hours. Operated later, the mortality is extremely high, as is also the case in multiple gunshot wounds); in gangrene; in certain acute intussusceptions; in stricture; in localized tuberculosis; in tumors; in certain forms of adhesions; in certain cases of artificial anus and fecal fistula; in cases in which the viability of the intestines is in doubt through constriction; in interference with the blood supply, as in mesenteric thrombosis or through detachment of the mesentery; and in wounds involving more than one half of the circumference which do not allow of closure by simple suture.

Technic of Operation.—The gut, the site of the lesion, is drawn outside the abdomen and several inches of healthy gut with it. Should adhesions be present, these should be dealt with gently and all hemorrhage arrested. Infected fluid, if present in the peritoneal cavity, is rapidly sponged away. The affected loop of gut, with several inches of healthy gut, is isolated with laparotomy sponges in such a manner as to guard the peritoneal cavity against the possibility of infection. In cases complicated by acute intestinal obstruction the distended gut above the lesion is opened and as much of its contents allowed to run away as will. This can be accomplished in the following manner: An assistant grasps the gut in 2 places, about 2 inches apart. A purse-string suture is inserted in the convexity of the gut, the gut is incised, the edges of the wound are held open by forceps, a small Paul or Mixter tube is inserted—a rubber catheter of large caliber may be used in place of the glass tube—and the purse-string is tied about the tube after inversion of the mucous membrane. In this manner intestinal contents are allowed to escape at a distance from the site of operation and soiling is avoided. A second purse-string, surrounding the first and at a little distance from it, is drawn down as the tube is withdrawn, while an assistant occludes the portion of the intestine, the site of the temporary enterostomy. Upon removal of the tube, the second purse-string is tied tightly, taking care that the peritoneal surfaces are inverted. As the removal of an inch or so of additional gut is of no consequence in these cases, it is best to pull sufficient intestine out of the abdominal cavity to allow of the making of an enterectomy through comparatively healthy intestine.

The loop to be resected is emptied of its contents by gentle pressure in an upward direction and an intestinal clamp applied on what is presumably healthy intestine. The contents of the loop are now expressed in a downward direction, and a clamp applied there. In obstruction cases, whether acute or chronic, there will be a marked difference in the character of the gut above and below the site of obstruction. Ordinary long-jawed artery clamps, such as the Kocher type, are applied somewhat more than an inch from the intestinal clamps on the loop to be resected. The entire loop is now held up and the blood supply in the mesentery studied. If there is doubt as to the blood supply of the portion of intestine to be left, the clamps are made to include more of the healthy gut.

With straight scissors, section of the bowel is made in a slightly oblique direction, a little more toward the convex border than the mesenteric border. Even if the intestine is sectioned straight across, there will be more retraction at the convex border than at the mesenteric border. The reason for making the incision in this way is to prevent too great narrowing at the site of the end-to-end anastomosis and also to render more certain the blood supply. Section of the gut is made about ¾ in. from the intestinal clamp. The open ends of the gut are now swabbed with moist sponges. If there is any bleeding at the mesenteric border, this is secured by ligature. Section of the mesentery may be made by either of 2 methods. With a pair of sharp-pointed scissors the triangular space where the leaves of the mesentery separate to surround the gut may be entered and the mesentery may be severed from the gut along this line, or a V-shaped section of the mesentery may be made. This latter is preferable in excising considerable portions of the gut and also in cases of malignant disease. In many instances, in thin mesenteries, on holding the mesentery up, the blood supply of the portion to be resected will be quite plainly indicated, so that the main branches leading to that portion may be ligated, and the V-shaped portion of the mesentery easily removed. In other cases it will be necessary to place ligatures before each cut with the scissors. In suturing the mesentery following the completion of the intestinal resection, in the case of the V-shaped excision of the mesentery with end-to-end anastomosis, the V is closed by a continuous suture beginning at the apex of the V and extending to the intestine where the mesentery is attached in approximately its normal position. If lateral anastomosis has been done with V-shaped excision of the mesentery, the edges of the V are slid past each other and are sutured to the anterior or posterior leaf of the adjacent mesentery. In case the mesentery has simply been detached from the intestine or is folded on itself and the fold sutured to the adjacent mesentery. Having removed the portion of affected intestine with a section of its mesentery, choice must be made as to the further steps to be pursued. Whether an end-to-end anastomosis by suture or button shall be done, whether the cut ends of the intestine shall be drawn in by purse-string sutures reënforced by Lembert sutures or by the Klapp method, and lateral anastomosis done, or whether the legs of the intestine shall be sutured together for a space of several inches and the open ends sutured outside of the abdominal wall, will depend upon the condition of the intestine and the condition of the patient. The instruments which have been used in opening the intestine must be discarded as soon as they have performed their duty.

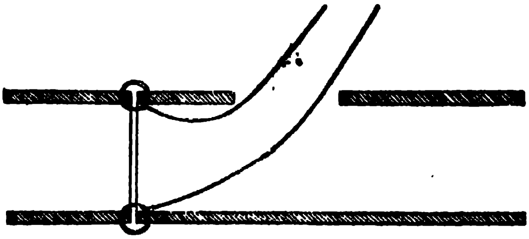

FIG. 12.—MAUNSELL'S METHOD OF END-TO-END ANASTOMOSIS (1).

Closure of the Ends of the Divided Intestine by Klapp's Method.—The intestine is first crushed with a heavy clamp and then divided with a Paquelin cautery, a long narrow clamp being applied to the cut end of the intestine and the intestine rolled up on the clamp. The serous surfaces thus brought in apposition are sutured, the clamp is loosened and removed, and the remaining apposed serous surfaces are sutured. By this method an extensive adhesion of serous surface is obtained, and the pressure arising within the intestine does not exert itself directly against the line of suture.

Closure by Purse-string Method.—The severed end of the intestine is crushed by a strong clamp, and while it is so held a purse-string suture of non-absorbable material is made to surround the intestine at a distance of ½ in. from the divided end. As this purse-string is drawn down, the divided end is invaginated and the clamp is withdrawn. A second purse-string at a distance of ½ in. reënforces the first.

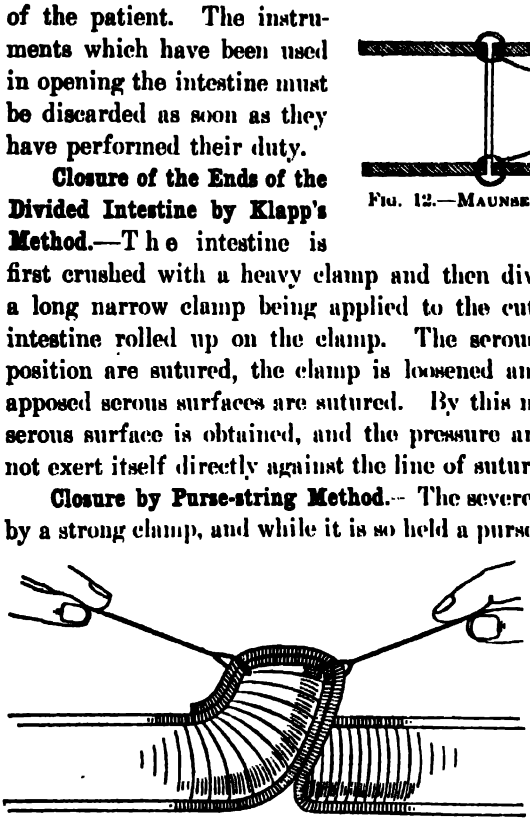

FIG. 13.—MAUNSELL'S METHOD OF END-TO-END ANASTOMOSIS (2).

End-to-end Anastomosis: Maunsell's Method.—The openings in the bowel are secured together by 2 long temporary stitches which include all the coats of the bowel, one being placed at the mesenteric attachment and the other directly opposite. These sutures are tied on the mucous membrane, the ends being left long to effect invagination (Fig. 12). An incision 1½ in. long in the long axis of the bowel through all the coats on the free border of the proximal loop, and somewhat more than 1 in. from the cut end, is made. The invaginating sutures are pulled through this incision, and by traction upon them the smaller or distal loop is invaginated into the larger or proximal loop, and by continued traction it is drawn out of the opening (Fig. 13). Upon the emergence of the invagination it will be seen that the peritoneal surfaces of the 2 cut ends are in accurate apposition. The temporary sutures are now held taut and separated so as to cause the 4 layers to lie side by side. A long, straight cambric needle armed with silk is passed directly through all the coats of the 4 thicknesses at least ¼ in. from the cut edge, thus placing 2 sutures at 1 passage of the needle. The center of this suture is drawn up and cut, and each half tied. This procedure is repeated until sufficient sutures have been passed to insure accurate apposition (Fig. 14). The traction sutures are now cut short, and the invaginated gut is drawn back gently. The incision in the long axis of the gut is closed by any of the methods of suturing previously described. The mesentery is now dealt with in accordance with the method used in resecting it. Should any doubt exist as to the security of the anastomosis Lembert sutures may be additionally placed. This is to be avoided whenever possible, as already the method of anastomosis has narrowed the lumen of the intestine by at least ¼ in. all the way around.

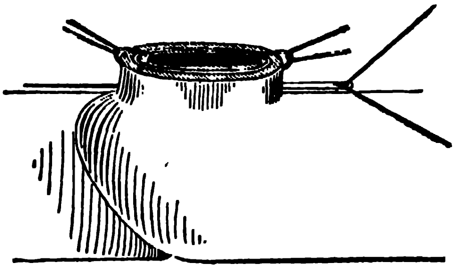
FIG. 14.—MAUNSELL'S METHOD OF END-TO-END ANASTOMOSIS (3).

This procedure allows of accurate suturing in end-to-end anastomosis, particularly in cases where one loop of the gut is smaller in diameter than the other. The method described presents one difficulty, and that is the securing of all the coats of the intestine when the sutures are passed in the manner described. This difficulty is caused by retraction of the muscular coat and eversion of the mucous coat. The difficulty can be overcome by trimming the mucous membrane wherever redundant. The sutures should not be so tight as to strangulate. Care should be exercised in reducing the invagination so as not to place too much traction on the suture line.

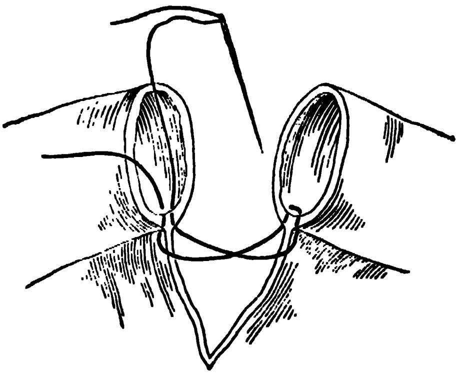
FIG. 15.—MODIFIED MESENTERIC STITCH TO SECURE ACCURATE PERITONEAL APPROXIMATION.

In placing the sutures left temporarily long for the purposes of invagination, it is well to exercise great care in placing the *mesenteric stitch* so as to secure accurate apposition. This can be done by making a mattress suture tied inside the bowel and including both mesenteric junctions in the following manner (Maunsell): The needle is entered from within the bowel slightly to one side of the mesenteric attachment. The point of the needle enters the triangular mesenteric space for about ⅛ in. and is then diverged to pierce the peritoneum. The needle then enters the other section of bowel in a reverse manner. These steps are repeated on the opposite side of the mesentery and the mattress suture thus formed tied within the bowel. A *modification* of this stitch and one which perhaps secures better approximation of the peritoneal coats is made by crossing the mattress suture. The suture is begun, as above, from within the bowel and is then carried through the opposing mesentery and into the bowel on the opposite side, diagonally in place of straight across. This procedure is repeated to complete the mattress suture, with the result, through the crossing of the suture, that the leaves of the mesentery are drawn more securely together and peritoneal approximation is secured (Fig. 15). As this is the weak point in end-to-end anastomosis, it is always best to place this stitch first.

Connell's Method of End-to-end Anastomosis.—This method is similar to Maunsell's operation in that all the knots are inside of the bowel; it differs from it in that this is accomplished, not by an extra incision into the intestine above the line of proposed suture, but by an ingenious method of tying the last suture. A cambric needle threaded with paraffin silk is passed from the mucous membrane side through the entire thickness of one arm of the gut at the mesenteric angle, approximately ¼ in. from the cut edge at the site of the mesenteric attachment. The needle is then passed from without inward, in a similar manner, at the mesenteric attachment of the other arm of the bowel. The ends of this suture are then tied together and used as a traction loop. It should be carefully placed so as to allow the anastomosis suture to secure seroserous approximation throughout. Its temporary object, used as a loop, is to facilitate the placing of the later sutures (Fig. 16).

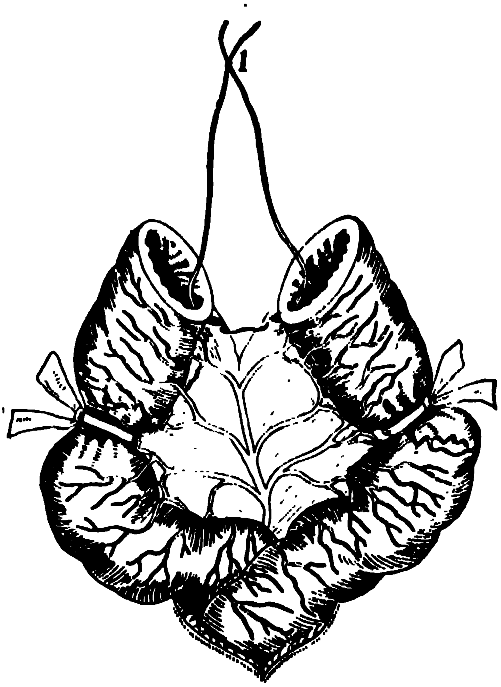

Fig. 16.—Connell's Method of End-to-end Anastomosis (1).

The field of anastomosis is divided into 3 equal parts in the following manner: At a point ⅔ distant from the mesenteric site on the convex border a suture is passed through all 4 walls of the cut ends, and that portion of the suture within each lumen is drawn up to sufficient length to form a loop to use

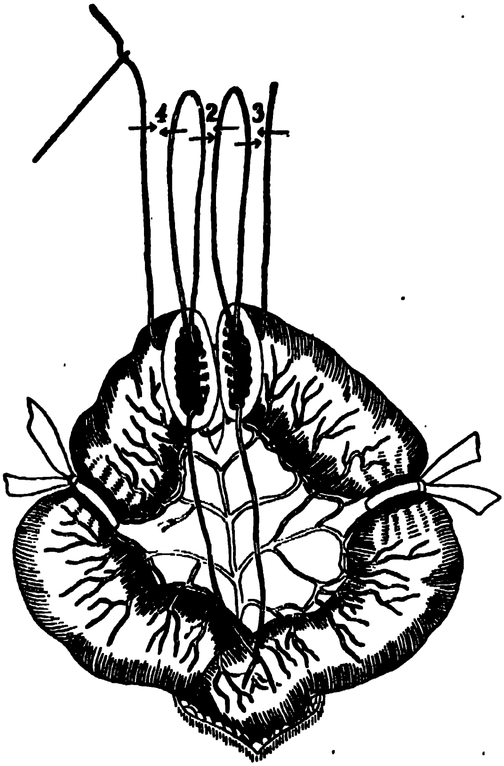

Fig. 17.—Connell's Method of End-to-end Anastomosis (2).

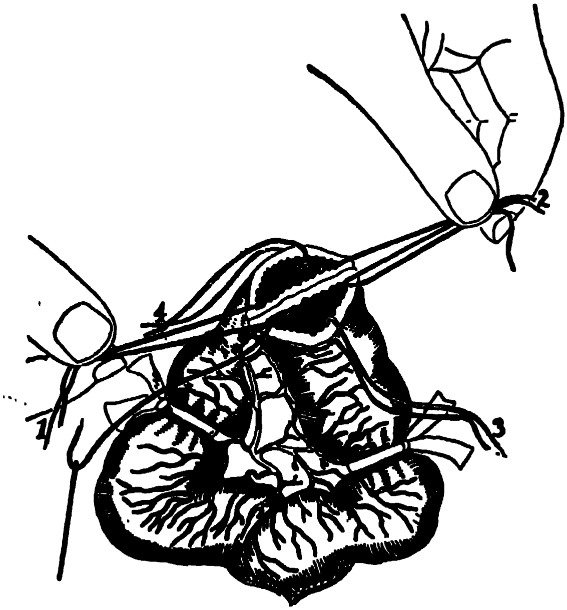

Fig. 18.—Connell's Method of End-to-end Anastomosis (3).

as a retractor and there cut. The corresponding ends of each loop are tied together (Fig. 17).

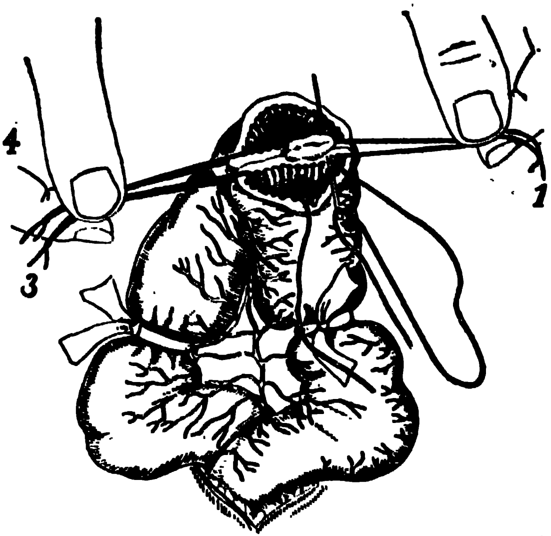

FIG. 19.—CONNELL'S METHOD OF END-TO-END ANASTOMOSIS (4).

An assistant, by drawing on the first and second loop, brings into apposition that third of the intestinal walls lying between these 2 points. The formal suturing of the intestine now begins. Beginning with loop 2, the needle pierces all coats of both segments of bowel and is there reversed and passed again through all coats of both walls parallel to and about ⅛ in. from the first part of the stitch just described, where it is tied. The free end of the suture is not cut, but held by the assistant with loop 2. This method of suturing is continued until loop 1 is reached, where a back-stitch is taken to prevent puckering (Fig. 18).

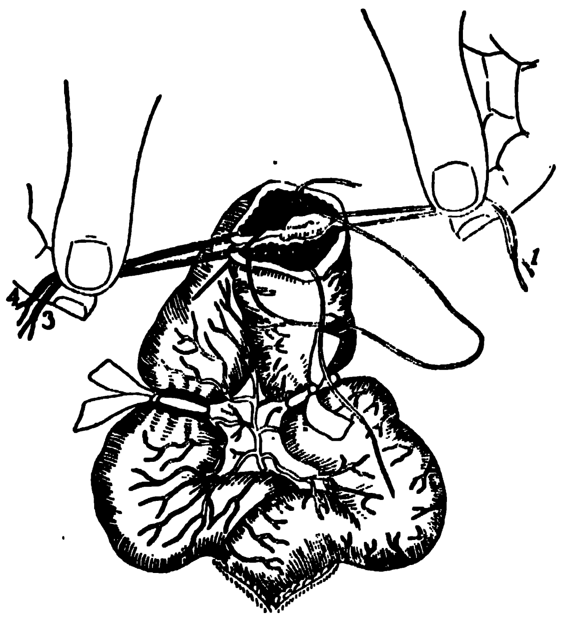

FIG. 20.—CONNELL'S METHOD OF END-TO-END ANASTOMOSIS (5).

Loop 2 is now cut away, and loops 3 and 4 take its place, so that a further third of both intestinal walls is brought into apposition. The suture is continued as far as loops 3 and 4, where a back-stitch is taken. This third of the suture includes the mesenteric border. This is shown as an elevation on the suture line in the illustration (Fig. 19).

The needle is now made to emerge from the lumen of the bowel at a point corresponding to that where the next stitch would be taken and appears on the serous coat of one cut end of the intestine (Fig. 20).

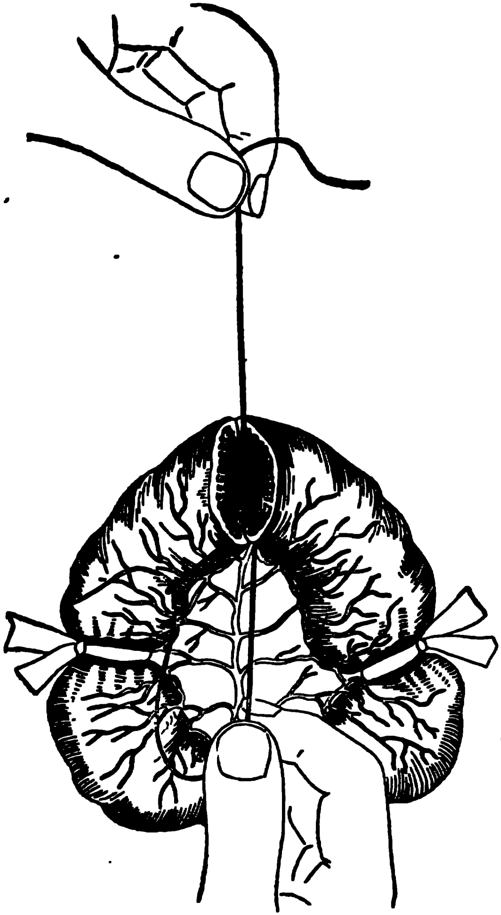

Fig. 21.—Connell's Method of End-to-end Anastomosis (6).

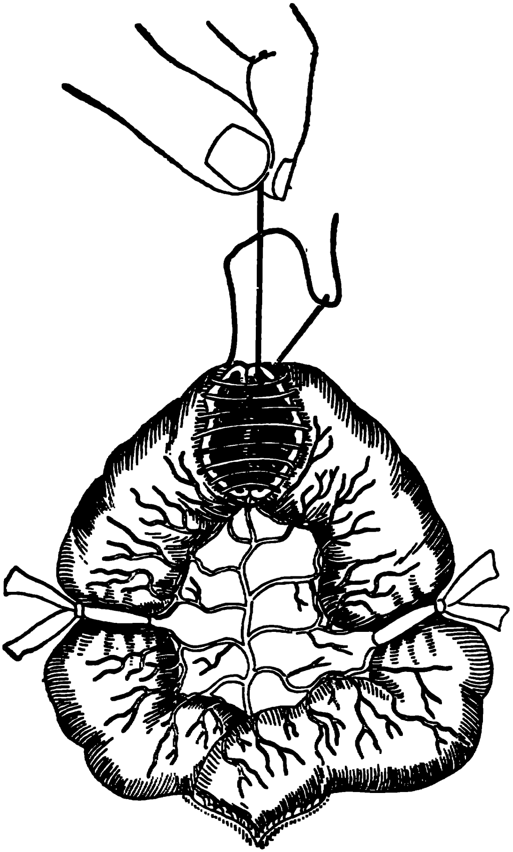

Fig. 22.—Connell's Method of End-to-end Anastomosis (7).

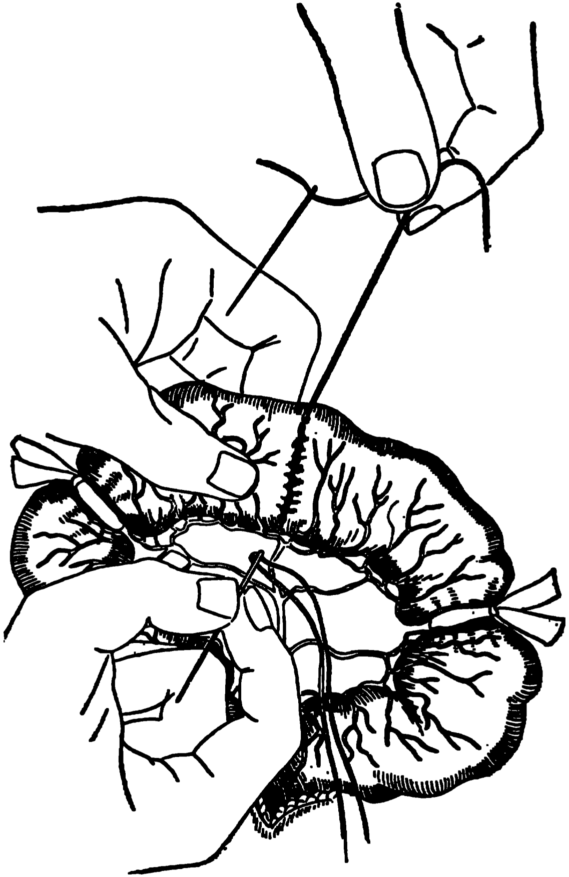

Fig. 23.—Connell's Method of End-to-end Anastomosis (8).

The suspending loops are removed. Their place is taken for the remaining third of the intestine to be sutured by the distal end of the suture and the proximal end of the suture used as tractors (Fig. 21). The last third to be sutured is the convex third of the intestine. That which was a complete section of the bowel has been transformed into a transverse incision. An accurate seroserous apposition is secured for this third in the following manner: The needle

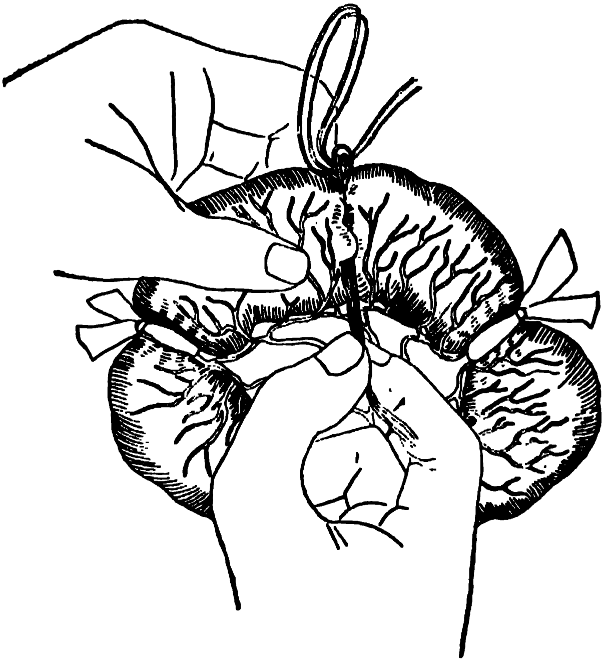

FIG. 24.—CONNELL'S METHOD OF END-TO-END ANASTOMOSIS (9).

is passed from where it emerged on one cut end (Fig. 20) to the other cut end (Fig. 21), where it is inserted from without inward at a point corresponding to that which would be pierced if the walls were in apposition. This suture is not drawn down tight. The needle is passed out again on the same side, entering the mucosa and emerging on the serosa ⅛ in. distant, and is then passed over to the opposite cut end, where it is inserted from without in and again emerges from within out on the same side. This is repeated alternately on the opposing edges until the necessary number of stitches have been inserted, none of which is drawn down tight, being left loose for the present (Fig. 22) to allow of the accurate placing of the suture. At the last stitch necessary to close the opening the suture ends within the lumen of the intestine and does not again pierce the wall as in the previous sutures (Fig. 22). This point should be ⅛ in. from the place where the suture originally started, so that when tied with the distal end it will complete the entire suture. The thread is brought out of the lumen alongside the

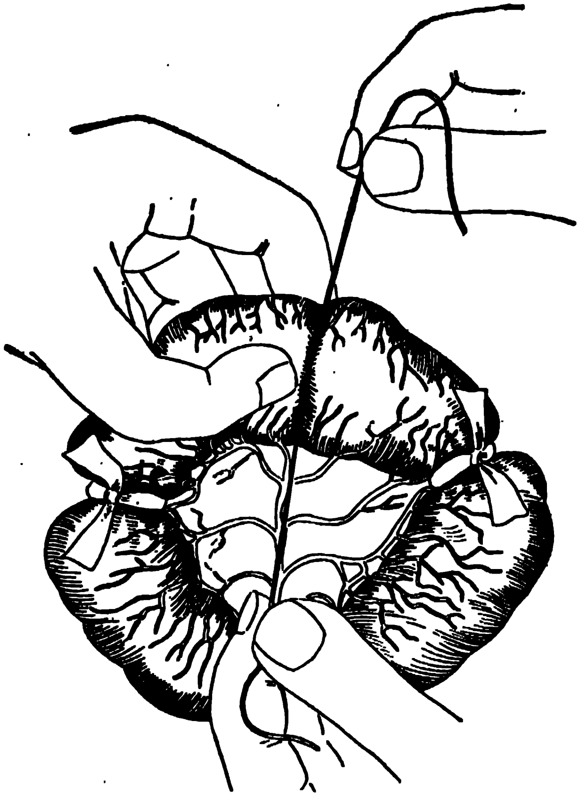

FIG. 25.—CONNELL'S METHOD OF END-TO-END ANASTOMOSIS (10).

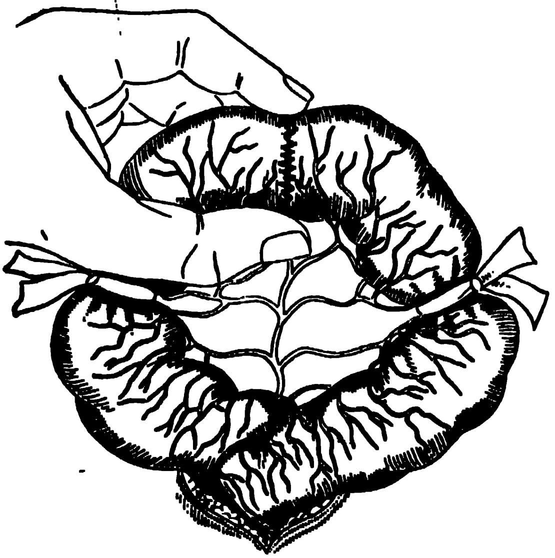

FIG. 26.—CONNELL'S METHOD OF END-TO-END ANASTOMOSIS (11).

distal end of the suture and the needle is removed. The loose sutures are now carefully drawn up, bringing into accurate apposition the serous surfaces at every point except where the distal and the proximal ends of the suture emerge.

A long cambric needle threaded is inserted, eye first, between 2 of the previously inserted stitches about opposite the point of emergence of the suture ends (Fig. 23) and is made to emerge at the same point where the suture ends emerge (Fig. 24). The loop of thread on this needle is then drawn up sufficiently to allow of the suture ends being placed through it (Fig. 24), whereupon it is entirely withdrawn, the result being that the suture ends appear at the point of withdrawal of the needle, thus securing approximation of the serous surfaces at the site of the last stitch.

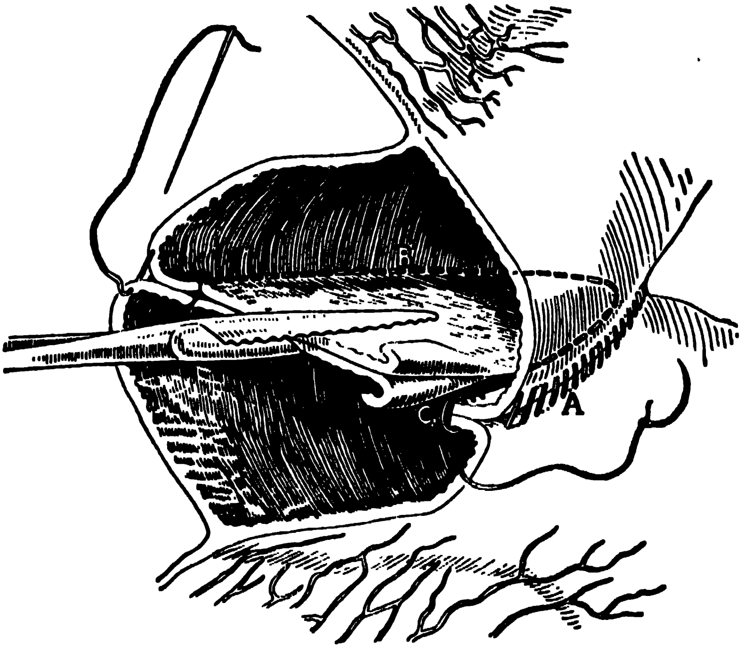

Fig. 27.—Horsley's Method of Enterorrhaphy.

Traction on the suture ends brings the opposing serous surfaces in close contact. The ends of the suture are then tied down snugly, the knot being buried deep between the serous walls (Fig. 25). Manipulation of the anastomosis will cause the intestine to resume its natural contour and the knot to slip within the lumen. All knots are thus inside the bowel and no stitches are visible on the outside (Fig. 26).

Horsley's Method of End-to-End Anastomosis.—This method provides a greater diameter for the sutured portion than that which is normal to the intestine. The ends of the bowel are placed convex surface to convex surface, side by side, with the openings in the same direction, and are held in position by a clamp (Fig. 27). The external or seroserous suture is applied to these surfaces. The septum thus formed is cut away and its edges are sutured. On the completion of this stage of the operation the suture is continued as an invagination suture, which completes the approximation.

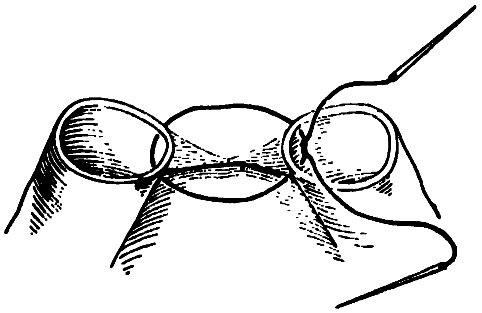

Fig. 28.—Willard Bartlett's Method of End-to-end Anastomosis (1).

Willard Bartlett's Method of End-to-end Anastomosis.—A No. 7 straight cambric needle is threaded with 2 very fine strands of silk of double length. The resulting 4 strands are twisted together so that the needle is as the end of a completed cable from which it cannot become detached. This is waxed and sterilized. A number of these sutures are kept in readiness for immediate use. Four strands are used because 2 are not enough to make a smooth cable. Two sutures of this kind about 14 in. long are tied together at the free ends, and the superfluous part of the thread cut close to the knot, the result being a strand somewhat over 2 ft. in length with a needle on each end. By referring to the illustration (Fig. 28) it is seen that the first step of the operation begins within the lumen of the gut, each needle being carried out of the viscus in such a manner as to embrace the site of the mesenteric insertion, the same being done to the mesentery of the bowel to the right as the 2 needles enter its lumen. This loop is tied down (Fig. 29). A few stitches of the continuous Connell type are taken, all the coats being pierced and a close approximation being secured as the threads are drawn tight. As shown in the illustration, by the needle next the reader most of these sutures are put in by making the in-and-out excursions in one and the same motion, in much the same manner that the Lembert sutures are applied, the difference being that all the coats are pierced. One-third of the circumference of the opening is secured in this manner. The same method of suturing is then repeated in the same manner with the needle shown in the illustration farthest from the reader, until the remaining ⅔ of the circumference is completed, when the 2 remaining ends are tied securely. Almost all of the stitches will be put in from the outside, and nowhere will anything but the peritoneal coat show. If the tension on the thread has been right,

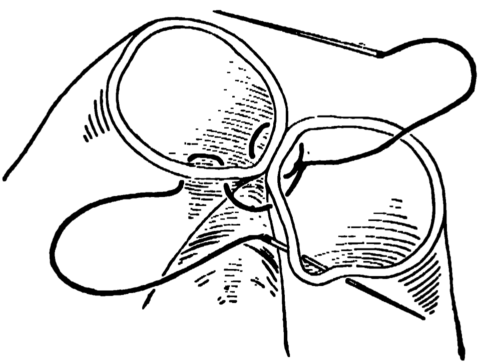

Fig. 29.—Willard Bartlett's Method of End-to-end Anastomosis (2).

it will be impossible to see any portion of it except the knot which, in Bartlett's hands, contrary to theory, has done no harm when left exposed, though he usually places one Lembert stitch over it.

End-to-end Anastomosis by Murphy Button.—Beginning at the convex border of the gut and from without, a running over-and-over purse string suture is applied around the cut edges of the gut, taking care to place the mesenteric portion of the stitch in the manner shown in the illustration (Fig. 30), so as to close the triangular space at the mesenteric attachment. A similar stitch is then placed in the other end of the intestine to be united. The larger half of the button, held by a pair of forceps with non-serrated edges, is inserted in the efferent opening. The purse-string suture is tied down, and with a flat probe any eversion of the cut surface is corrected. The same procedure is carried out with the smaller half of the button in the afferent loop. The smooth clamps securing the 2 halves of the button are removed and the button held in apposition by the thumb and finger grasping each loop behind the button. The 2 halves are now joined, taking care that they approach each other at exactly the proper plane, as otherwise the screw portions of the button may not exactly coincide and the button jam before it is completely together. Pressure is exerted until the button is locked securely, thus holding in firm apposition the peritoneal surfaces. The cut edges of the mesentery are secured in the usual manner.

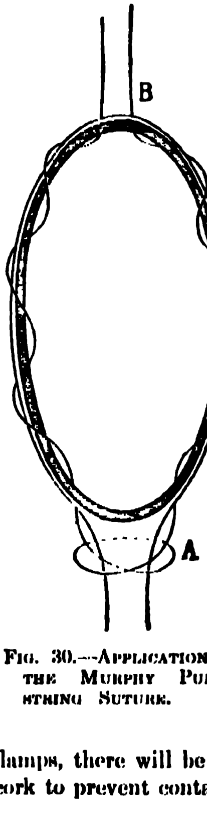

FIG. 30.—APPLICATION OF THE MURPHY PURSE-STRING SUTURE.

PRECAUTIONS.—Each button must be tested before using in order to ascertain that it is mechanically perfect. The screw portions of the button must not be grasped by serrated forceps, as injury to this portion of the button will result in failure to properly close the button. The spring must not be too stiff, or too rapid sloughing may occur. If the portion of the intestine to be used in the anastomosis has been properly freed of its contents and secured by intestinal clamps, there will be no necessity for blocking the lumen of the button with cotton or cork to prevent contamination of the field.

Following Murphy button operations, the button usually passes in 9 to 18 days, but may be delayed a great deal longer. Radiography will show its change of position. The button may pass as far as the rectum and become lodged there. In this event the patient will complain of *rectal irritation*. Digital examination will result in its discovery and removal. Occasionally the button will not pass into the large intestine and will require removal by secondary operation. *Obstruction* at the site of the button occasionally occurs. *Perforation* at the site of the button has been reported, due either to lack of proper blood supply or to poor reparative powers.

La Place's Method of End-to-end Anastomosis.—The forceps, of 5 different sizes, consist of 2 parts which are really hemostatic forceps curved into a semicircle on each side; when held together by means of a clasp they open as 2 rings (Fig. 31). They serve the same purpose as Senn's rings, bringing serous surface to serous surface. Sutures are introduced all around, except where the forceps penetrate the lumen. The forceps are released by loosening the clasp, and then withdrawn a blade at a time out of the small unsutured opening which is finally closed by a stitch or two.

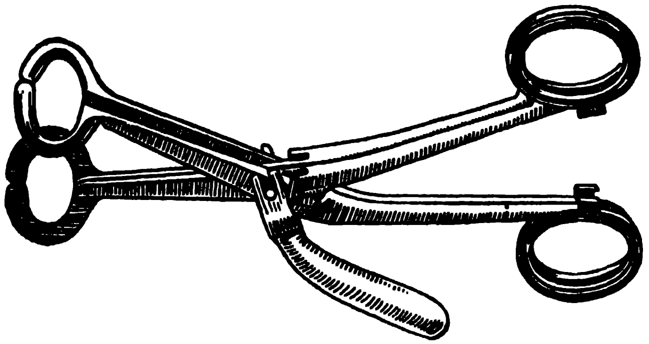
FIG. 31.—LA PLACE FORCEPS FOR END-TO-END ANASTOMOSIS.

The 2 cut ends of the bowel are first united by fixation stitches at the 4 cardinal points to assure the correct relation of the mesentery of the 2 ends of the gut. The forceps is introduced between 2 of these stitches and the blades are opened so that one blade penetrates one end and the other the other end of the intestine. The serous surfaces are inverted by pushing them between the clamps or by placing a suture around the ununited ends between the blades. The forceps is clamped, securing serous surface in apposition to serous surface. The sutures are then applied all around the clamped surfaces to the point where the forceps penetrates the gut. The clamp is removed, half of the forceps is removed, and then the other half. The operation is completed by adding 1 or 2 stitches to close the opening through which the forceps was removed. By this method the caliber of the gut is preserved.

Lateral Anastomosis by Suture.—This is performed in the same manner as gastro-enterostomy. Should resection have preceded the anastomosis, the cut ends of the intestine are inverted by one of the methods previously described. An inch or more from the turned-in end of the gut the convex border of the intestine is picked up by mosquito forceps for a space of 5 in., and freedom from interference by intestinal contents is secured by a gastro-enterostomy clamp, which also serves to steady the loop and facilitate suturing. The same procedure is carried out on the other end of the bowel, and the clamps are placed side by side with the gut in the direction of the fecal current. A needle scratch 3 in. long, between the mosquito clamps, is made in the convex border of each segment. This marks the site of the anastomosis. A continuous Lembert suture is introduced, joining the opposed peritoneal surfaces ¼ in. from this scratch and extending somewhat beyond it on either end. Threads for this purpose should be 20 to 24 in. in length and should be double-armed. This suture is now laid aside until it is time to use it to complete the anastomosis. The scratch on the walls of the gut is deepened with a scalpel through the muscular layer, until all of the coats of the intestine have been divided down to the mucosa; this will pouch up; the edges of the cut will be well defined. With a double-armed suture, 20 to 24 in. in length, beginning at the middle of the opposing surfaces, all the layers of the bowel incisions except the mucosa are sutured in an over-and-over manner, the suture turning and extending somewhat beyond each angle. This suture is then laid aside. The mucosa is then opened by means of sharp-pointed scissors, and its edges, if redundant, trimmed. The mucosa is gently swabbed clean with a sponge. By means of a catgut suture the mucosa is whipped over and over completely around the opening. This suture is for purposes of hemostasis.

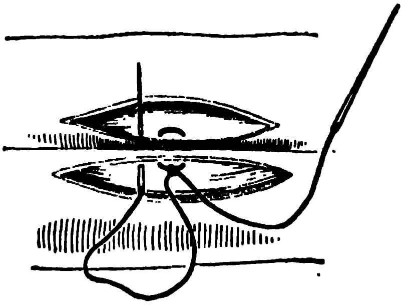
FIG. 32.—WILLARD BARTLETT'S METHOD OF LATERAL ANASTOMOSIS.

The second suture uniting all the layers except the mucosa is now taken up and completed, placing the over-and-over suture in such a manner as to roll in the cut edges, the suture continuing from each angle and ending in the middle of the anterior portion of the anastomosis. At this point it will not be possible to invert the last stitch. This suture is then tied and cut short. The first or the Lembert suture is now taken up, and, working from each angle, is completed and tied on the peritoneum of the anterior portion of the anastomosis, but not directly over the knot of the preceding suture.

The particular underlying principle of this operation is the securing of the layers of the gut by separate sutures. Any of the methods of suturing may be employed in its performance. As originally used, it consisted of 2 layers (Abbe) and was a lateral opening. It is the most secure of all forms of anastomosis. A few stitches of catgut uniting the incision in the mesentery to the adjacent mesentery complete the operation.

WILLARD BARTLETT'S METHOD OF LATERAL ANASTOMOSIS.—With a double-armed thread, the middle of the suture is tied within one lumen at the central point of the posterior suture line, leaving the 2 needles ready for use (Fig. 32). The one on the left is employed to make an ordinary continuous Connell suture to the left of the knot. This is continued until the corresponding corner is turned. The same maneuver is carried out with the needle on the right hand until the other corner is turned. The advantage of beginning this suture in the middle is that both of the difficult corners can be turned with the wound wide open, which is not the case if the operator begins at either end. The anterior row of sutures is now finished by inserting the stitches in the same manner as shown by the needle next the reader in Figure 29. Each thread makes half of this anterior row, the two meeting at the middle of the wound, where they are tied. A single Lembert suture buries the knot.

Lateral Anastomosis by Elastic Ligature.—This method (Fig. 33) has to recommend it only the element of time consumed in its application. It was first used by J. McFadden Gaston and subsequently by McGraw. By its use an anastomosis can be accomplished in 3 minutes. The chief objections to it are that 3 to 5 days are required before the anastomosis is complete, that through errors in technic the opening may be irregular, and that the ligature may not cut completely through. Its use is indicated in cases of acute intestinal obstruction in which lateral anastomosis is done and the bowel above the site of obstruction made the site of an artificial anus in patients whose condition does not warrant a more elaborate procedure. An objection to its use is that it requires special instruments for its performance. McLean has devised a needle which renders the technic simpler. F. T. Murphy has added a useful detail by the introduction of a knot in the middle of the ligature, which increases the rapidity of the cutting-out process.

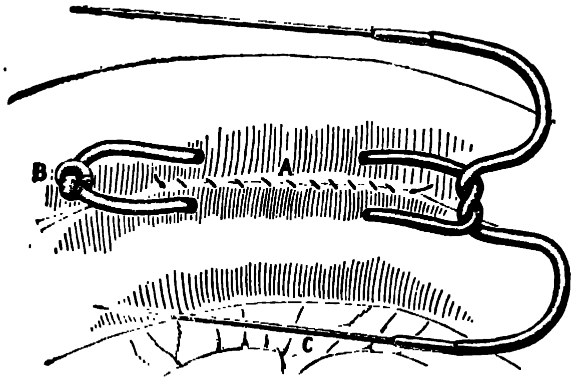

FIG. 33.—LATERAL ANASTOMOSIS BY ELASTIC LIGATURE. A, Posterior line of suture; B, knot introduced by F. D. Murphy to increase the rapidity of the cutting out process; C, McLean needle.

TECHNIC.—The ligature is made in 3 sizes, 5, 4, and 3 cm. The larger the size the stronger the elastic, and consequently the more rapidly the cutting-out process occurs. The technic is much aided by the use of the McLean needle. This needle, made in several sizes, has an eye open on one side of sufficient size to easily accommodate the appropriate ligature when this is placed on the stretch. A movable ferrule slips down and is forced over the ligature, thus making a smooth connection between the needle and the ligature, and so preventing tearing during the introduction. The loops of intestine selected for the anastomosis are placed side by side and joined together by a continuous Lembert suture. Both ends of the elastic ligature are threaded and a half knot placed in the center of the ligature. The point of one of the needles is now introduced into the lumen of the intestine. It is essential that the point be introduced within the lumen with certainty, otherwise the mucosa may be pushed before the needle. The needle is pushed along the lumen of the gut, gathering a longitudinal fold about 2 in. long, and is then forced out of the bowel as nearly as possible at right angles to the bowel wall. One hand grasps the knot, while the other puts the rubber ligature on the stretch and draws it through the openings down to the knot, an assistant sponging away the intestinal contents which are brought out on the ligature. The same procedure is carried out with the second needle on the other loop of the bowel. The ligature is now tied down in the first half of a square knot over a piece of strong silk; to prevent the posterior line of the Lembert suturing being pulled into the knot the flat end of an anatomical forceps is placed within the loop of the ligature and against the posterior suture line. This is withdrawn when the joining of the ligature is almost completed. The silk is now tied down in a square knot to secure the rubber from slipping, the second half of the knot is completed in the same manner and the ligature cut short. The continuous Lembert suture is now completed. Care must be taken to tie the rubber as tightly as possible and to secure it with silk, as otherwise a complete cutting out of the intervening tissues will not occur.

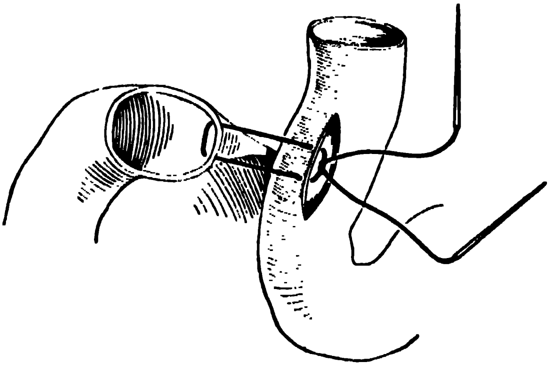

FIG. 34.—WILLARD BARTLETT'S METHOD OF END-TO-SIDE ANASTOMOSIS.

Lateral Anastomosis by Murphy Button.—On account of the ease with which a lateral anastomosis by suture can now be done, lateral anastomosis by the original lateral anastomosis button is no longer used to any extent. The ordinary end-to-end anastomosis button, however, is quite useful in emergencies for making short circuits in operations for obstruction, in patients too far gone to stand a more extensive operation, and in places inaccessible to suture.

Willard Bartlett's Method of End-to-side Anastomosis.—The middle of a double-armed suture is tied down in such a manner as to securely fix the site of the mesenteric attachment of the bowel to be implanted to the center of the lateral anastomosis opening (Fig. 34). The posterior row of sutures approximates the 2 viscera, being inserted after the continuous Connell method, while the anterior row is placed as shown by the needle next the reader in Figure 29. The resulting ends of thread are tied and a single Lembert suture buries the knot.

OPERATION FOR INTUSSUSCEPTION

Reduction of an Intussusception.—In reducing an acute intussusception the mass should, if possible, be brought outside the abdomen. Traction should not be made upon the intussusception, but reduction should be effected by squeezing the intestine below the intussusceptum and so forcing it out.

Should reduction be impossible by this means, resection or other operative procedure on the gut itself is indicated. In case any gangrene exists at the neck, no attempt should be made at reduction. Pressure should be firm, gentle, and continuous. Any injury to the peritoneal coat should be carefully sutured after reduction. If the tumor is irreducible but not gangrenous and the patient's condition good, resection of the entire mass is advisable. If the patient's condition is not good, under the same conditions, Barker's or Coffey's operation is indicated. If gangrene exists, excision with the formation of an artificial anus or excision with lateral anastomosis is indicated.

In some cases the patient's condition is so bad that no more can be done than to bring the affected intestine outside the abdomen while rapidly forming an artificial anus above the site of obstruction. In other cases there is time for a lateral anastomosis in addition to this procedure. Usually, however, the cases needing resection are so nearly moribund that no procedure will be of avail.

After-treatment of Intussusception.—If the intussusception has been reduced, cathartics are contra-indicated for a considerable period. The bowels are moved by enema after the first 48 hours.

Treatment of Chronic Intussusception.—If the condition of the patient is such as to stand any ordinary procedure, the intussusception is reduced as completely as possible and either a Barker's or a Coffey's operation, or a resection of the affected bowel is performed.

Barker's Operation for Acute Intussusception.—After reducing the intussusception as far as possible, the affected intestine is brought outside the abdomen, secured by intestinal clamps, and the abdominal cavity suitably protected. A continuous Lembert suture is passed around the neck of the invagination attaching the intussusceptum to the intussuscipiens around the neck of the tumor. A longitudinal incision on the convexity is made in the intussuscipiens, and the intussusceptum pulled out through the opening. With a long, straight needle a suture is passed as near the neck of the intussusceptum as possible, completely transfixing it. At right angles to this, at the same level, a second suture is passed, also completely transfixing the neck. The intussusceptum is cut away just below the level of these sutures. The center of each suture lying within the lumen is picked up and cut, thus forming four loops. These are tied down as individual sutures, securing the intestinal walls in apposition. More accurate apposition is obtained by using the loops as guides and rapidly placing a continuous suture involving all the coats. The longitudinal incision in the intussuscipiens is then closed.

Coffey's Operation.—An attempt is made to reduce the intussusception. If this is found impossible, the intussusception is delivered without the abdomen and the abdominal cavity protected. A primary incision (1) is made as shown in Figs. 35 and 36. As this is done, all infective fluid is sponged away. It may be necessary to partially section the ileocecal valve if constriction exists at this point. The intussusceptum (2) is now withdrawn and wrapped in gauze. The fluid inside the intestine is sponged away and a long piece of gauze (3) is packed within the cecum to prevent regurgitation of intestinal contents. The middle layer of the intussusceptum (4) is now sectioned by a circular incision and bleeding points (5) on it controlled by clamps. The healthy intestine (6) is sectioned between two clamps (7). The primary in-

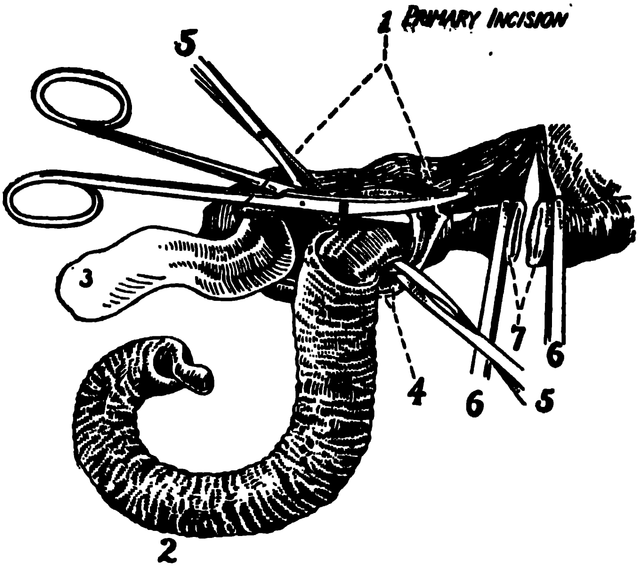

FIG. 35.—COFFEY'S OPERATION FOR INTUSSUSCEPTION.

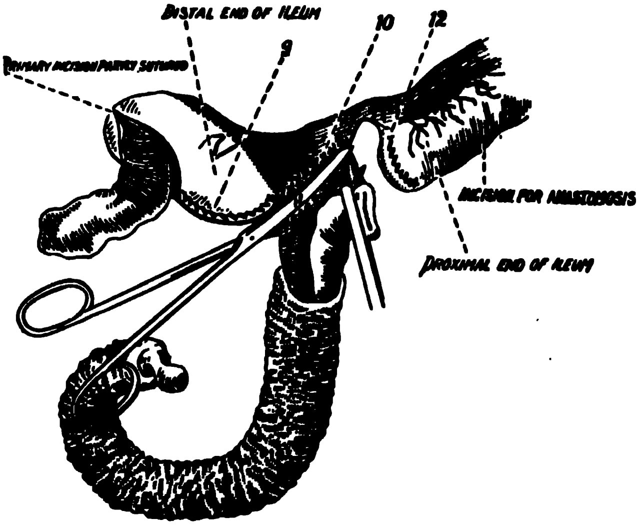

FIG. 36.—COFFEY'S OPERATION FOR INTUSSUSCEPTION.

cision is now completed (8), laying open the distal end of the ileum and freeing the intestine to be removed. The distal end of the ileum is partly sutured (9), *leaving an opening large enough for a lateral anastomosis.* The gangrenous portion of the intestine is now held only by its mesentery. This is ligated in sections (10), and cut away with scissors (11). The proximal end of the ileum is sutured (12) and the clamp removed. The distal and proximal ends are brought together, and a lateral anastomosis made.

OPERATIONS UPON THE INTESTINES DONE IN TWO STAGES (MIKULICZ OPERATION)

It is at times desirable, in the case of a tumor or intussusception, the immediate removal of which would involve too great risk to life, to loosen the portion of the intestine which is the seat of the growth and fasten it outside the abdominal wall. If obstruction is present, the intestine is immediately opened. At the end of 48 hours sufficiently strong adhesions having formed, the mass is cut away. The primary dressing consists of abundant fluffed-out gauze. This is changed several times daily as soiled. Later a secondary operation, either by Dupuytren clamp or a formal laparotomy, is undertaken to restore the continuity of the intestinal canal.

OPERATION IN INTESTINAL OBSTRUCTION

Location of the Obstruction.—If obstruction in the course of the small intestine is suspected, a free abdominal incision should be made to one side or the other of the median line through the corresponding rectus muscle, with its center at the level of the umbilicus; it may be necessary to extend the incision in an upward or downward direction. The facility with which the operation is performed will depend greatly upon the assistant's care of the exposed intestine. Before allowing any intestine to escape, the operator's hand is introduced into the abdomen and a tentative exploration made. The various sites of abdominal hernia are explored; following this, a general search of the peritoneal cavity is made. It may be this will demonstrate a band or kink. If so, the incision is sufficiently enlarged and an endeavor made to correct the mechanical difficulty without allowing any more of the intestine to escape than can be helped. As fast as intestine does escape from the abdomen it is covered by warm cloths to preserve its natural warmth, the warmth in these cloths being retained by placing hotter cloths upon them. This method is far preferable to the removal of the cloths and the application of others, as this latter not only takes time, but allows of cooling and exposure of the intestine, things to be prevented as far as possible.

If the primary manual exploration for the site of the lesion does not reveal anything, the hand is passed into the pelvis, where, if the obstruction is in the course of the small intestine, some collapsed loops will usually be found. These may be traced upward to the site of the obstruction. Failing this, the distended intestine is traced downward, this latter being the less preferable on account of the injury to the gut.

The incision will disclose distended coils of intestine. Inspection of these will discover whether they are large or small intestine. The escape of serous fluid usually indicates strangulation. If the fluid is slightly bloody, torsion is probably present. Such fluid is found in obstructions involving torsion of the mesentery. Lymph on the intestinal wall indicates the presence of inflammatory changes in the peritoneum.

Having located the obstruction, that portion of the bowel which is the site of obstruction is brought outside the abdomen, if possible; if this is not possible, the surrounding intestine is walled off and the operation proceeded with. Whatever procedure is indicated, whether a section of a band, a resection of an intussusception, or resection of the gut, the operative procedure should be carried on with due formality. It is not by haste that such patients are saved, but by following the underlying principles of intestinal surgery in a formal manner, making each step count and using as few motions as possible. Should the distended coils of intestine interfere seriously with the performance of the operation, or should the distention be so marked as to preclude the possibility of replacing the distended gut in the abdomen without injury, or should the obstruction have been present for a sufficient length of time to fill the distended gut with putrid material, it will be necessary to empty the coils above the site of obstruction. This is best done before proceeding with the actual operation for overcoming the obstruction.

It may well be that the patient's condition is such that a prolonged search for the site of obstruction is impracticable, in which event the only safe measure to be employed is the making of an artificial anus. For this purpose a loop of gut as near as possible to the site of obstruction should be utilized. Usually in the small intestine the site of obstruction is readily identified and dealt with, and even if the patient's condition is such as not to admit of resection or radical operation, still the site of obstruction can be brought outside the peritoneal cavity and treated by the method of Mikulicz. The first point to be borne in mind in the treatment of these cases is the saving of the patient's life, and any makeshift that will conserve this end is to be employed. In rare instances the cause of obstruction will be found to be an internal hernia. The course to be pursued in regard to the local operative treatment of an obstruction will depend upon the conditions present both as regards the mechanical condition which obtains and also the condition of the gut, whether gangrenous or not.

Resection of Intestinal Bands.—After sectioning a band for the relief of intestinal obstruction, as much of the band should be removed as practicable, in order to avoid its becoming adherent to other parts of the intestine. Each end of the band is clamped and ligatured, the free portion being cut away.

Windows in the mesentery or omentum, through which small intestine is herniated, producing obstruction, should be enlarged sufficiently to allow of ready reduction of the intestine, subsequent to which these openings should be sutured. In dealing with adhesions between the intestine and abdominal wall which do not peel off easily, portions of the parietal peritoneum should be excised rather than the intestine be torn away from the wall, and the consequent gap subsequently sutured if time permits.

In intestines matted together the greatest care is necessary to avoid injury, yet these kinks, twists, and torsions must be straightened out.

After-course in Cases in Which Intestine Which Has Been the Site of Obstruction Is Returned to the Abdomen.—In cases in which there is slight damage to the gut and few adhesions, the after-course is usually satisfactory. An enema is given to move the bowels directly the patient has recovered from the anesthetic.

Complications.—INTESTINAL TOXEMIA.—The patients recover from the shock of the operation and the bowels move freely, the stools being very foul-smelling. The abdominal pains continue, the pulse is about 100, and the temperature 100° to 101° F. There is neither rigidity nor distention. *Treatment* consists in repeated enemata and saline catharsis to rid the intestinal tract of the toxic products of putrefaction.

Obstipation.—The vomiting stops, the patients react from the operation, but the bowels do not move and the patients do not feel well, though all else is favorable. In such cases enemata will relieve the distress.

Peritonitis.—This may be caused by the presence of infected fluid. The onset will be immediate, the course rapid, and death quickly supervenes. *Treatment* consists in immediate laparotomy and drainage, with the patient in the elevated head and trunk position. Examination will show but slight changes in the intestinal loop which was the seat of the incarceration. We have to deal with 2 classes of cases: first, those in which perforation may be expected and for which provision has been made at the time of operation by suturing the suspected loop in the neighborhood of the wound and by drainage, or by the formation of an artificial anus with the affected loop; second, cases in which the returned gut is apparently recovering and yet later perforates. In the first class, as perforation has been expected, a suitable provision has been made, and providing the case survives the operation, recovery may be expected with an artificial anus. In the second class of cases a normal course may be followed for 24 or 48 hours, the bowels may move and recovery be confidently expected, when suddenly abdominal pain and collapse occur with evidence of a rapid peritonitis, the picture of a perforation without adhesions. The abdomen should be immediately opened, either the gut resected, or, preferably, an artificial anus made, the peritoneal cavity cleansed, and the elevated head and trunk posture employed. Perforation may be preceded by the formation of sufficiently strong adhesions to allow of abscess formation. Such cases usually recover if the site of perforation is in the neighborhood of the wound. The abscess may point into the wound or be opened through the wound when evidences of this condition (septic temperature and tenderness) present themselves. Should these symptoms occur, the wound is to be carefully opened and the fecal abscess evacuated. The opening of such an abscess should not be delayed in the hope that stronger adhesions will form, as intestinal adhesions surrounding fecal abscesses rarely become very firm and, if opening of the abscess is delayed, these weak adhesions will be quickly broken down by the tension of the accumulation. On account of the weak nature of these adhesions, the abscesses should be opened very carefully in order to avoid soiling the peritoneal cavity and a soft rubber drainage tube should be inserted. The outer dressings are changed every 2 or 3 hours. Phlegmon of the abdominal wall or gravitation abscesses may complicate wounds of this character.

PARESIS OF THE AFFECTED LOOP.—At the operation the intestine may apparently recover its tone and be returned to the abdomen, yet the symptoms of obstruction persist, vomiting continues, meteorism is extreme, and collapse and death follow in from 24 to 48 hours. At autopsy the affected portion of the gut is found dilated. This is due to a paresis occurring at the site of obstruction. The same symptoms persist and may be due to mechanical conditions when section of adhesions has not been complete.

Treatment.—In cases of paresis following operations for obstruction a secondary laparotomy should be undertaken and an artificial anus made above the affected loop. In cases in which symptoms of obstruction persist after apparent relief, an immediate exploratory laparotomy should be made.

STENOSIS.—Stenosis of the intestine may occur some months following operation. The stenosis occurs at the site of a previous strangulation and is caused by a cicatricial contraction of a gangrenous area in the mucous membrane.

After-treatment.—GENERAL TREATMENT.—In cases not resected the diet should be fluid for the first few days, and the contents of the small intestine kept liquid by giving dram doses of sulphate of magnesia every few hours. In *resection* cases water is given as soon as anesthetic vomiting ceases, other fluids in 24 hours, and soft diet after the fourth day, following which other foods are added. The bowels are moved with enemata.

WOUND TREATMENT.—If the wound is completely sutured, the treatment is the same as that for any aseptic wound. If a drain has been led down to the affected loop to afford an outlet in case of leakage or perforation, this should be removed at the end of 48 hours; if the drain comes away clean, it should be replaced by a small strip leading down to the peritoneum, which is removed and not renewed at the end of 24 hours. If leakage occurs, as shown by the telltale drainage strip, it will follow the course of the provisional drain. Leakage requires enlargement of the drainage opening and the gentle insertion of a soft rubber tube.

The Amount of Intestine to Be Resected in Acute Intestinal Obstruction.—In acute intestinal obstruction of long standing the bowel above the site of obstruction for a distance of a foot or more is the site of an ulcerative process, and the gut is paretic for this distance in consequence of the ulcerative conditions. The contents of the intestine above the site of obstruction are poisonous, and if allowed to pass onward into the healthy gut below the site of obstruction, absorption may result disastrously. If the paresis is complete, this material will not pass on, but also the obstruction will not be relieved. If this difficulty is met with, one of 2 methods of treatment is indicated; either a resection of several feet of intestine, together with its putrid contents, or drainage by an artificial anus above the site of obstruction. Barker prefers the former, as by this means it is possible to remove at once all of the septic bowel and its contents, and with this the greatest dangers to the patient. These are the dangers of peritoneal infection with or without sloughing or perforation of the bowel and the toxemia from absorption of the liberated contents as they pass into the intestine below. Barker estimates that a bowel distended to only 2 in. in diameter contains for every foot more than 1 pint of putrid material. A third course is resection of the site of the obstruction with temporary drainage of the intestine above, or the bowel above may be temporarily opened at the time of operation and its contents washed out. In any event the putrid contents of the bowel must be removed.

Results in Resection of the Intestine.—It is practically impossible to tabulate trustworthy statistics on account of the variety of lesions and methods employed. In general it may be said that in acute lesions in which operation has been performed within 24 hours of the onset the prognosis is good; beyond 24 hours the prognosis is bad. Mortality, being due to delay in diagnosis, is, for the most part, in cases in the hands of the general practitioner. The mortality in chronic cases depends, for the most part, upon the selection of cases and the skill of the operator.

OPERATION FOR LANE KINK: COFFEY METHOD

The adhesions are separated, thus freeing the terminal portion of the ileum. Several purse-string sutures are placed in the anterior leaf of the mesentery of the ileum, opposite the site of kinking, and are tied down with the result that the mesentery is shortened, the ileum is elevated and straightened, and the kink relieved. In this manner the mesentery can be shortened for 2 in. or more, thus keeping the intestine away from its former adherent position. In some instances the raw surface caused by the separation of adhesions is covered by suturing the peritoneum transversely across, though this is not always possible. The method has proved successful whether the raw surface has been covered or not. The after-treatment consists in placing the patient on the left side with the foot of the bed elevated 12 or 14 in.

OPERATIONS UPON THE OMENTUM AND MESENTERY

Hemorrhage from the Omentum.—Having opened the abdomen and found hemorrhage, the first question to decide is whether this comes from the omentum. The injury to the omentum may be vertical or transverse to the blood vessels. The blood may escape into the free peritoneal cavity or escape between the folds of the omentum and form a large hematoma. The abdominal wound is enlarged to admit of free inspection of the omentum. The wounded portion is brought clearly into view, and if there is a vertical rent, the bleeding vessel is secured and the rent sutured. Should the rent be transverse, more vessels will necessarily be involved and the hemorrhage will be more severe. If at all extensive, it is best to remove the portion of the omentum below the transverse rent. Small rents may be sewed up after securing all bleeding points. If a hematoma is present, it is best to excise the entire infiltrated mass. In dealing with wounds of the omentum, owing to its delicate nature, the structure must be handled with extreme care. Pulling may result in rupturing other vessels. Sutures should be placed very carefully, avoiding injury to other vessels by the needle. The suture and ligature material should be fine. All tabs of omentum should be excised and raw surfaces either rolled in or approximated to prevent adhesions to the intestine with a possibility of subsequent obstruction. If accidental pricking of a vessel occurs the bleeding point should be at once seized and secured by surrounding it with part of the stitch, otherwise a hematoma will rapidly form. Care should be taken not to leave any apertures in the omentum through which a loop of intestine may pass and become strangulated.

Bleeding from the Mesentery.—On opening the abdomen there is no blood or very little anterior to the omentum. On raising the omentum, however, a large amount of blood will be disclosed. In such a case the bleeding is probably from the mesentery. The incision is enlarged and the omentum and transverse colon are brought outside the abdomen, laid on a warm laparotomy pad, and a second pad placed over them. The root of the mesentery is identified and temporary pressure made there until the bleeding point is found. A systematic search is now made for the source of hemorrhage. While an assistant grasps the mesentery and temporarily controls the hemorrhage, the small intestine is delivered through the wound, beginning at the ileocecal juncture, and a systematic search of its mesentery is made. As fast as the intestine is delivered, it is again replaced by an assistant, so that at no time is very much of the intestinal surface exposed; at the same time a third assistant sponges away the blood and keeps the field as clear as possible. Having determined the source of bleeding, local pressure is made to control it, while the intestines are packed out of the way. Here also the securing of the hemorrhage depends upon the character of the wound and its site. If the wound is in the long axis of the blood supply near the intestine, a single suture on the needle may be passed around it and tied down. If, however, there is a transverse tear of the mesentery near the intestine, the subsequent procedure will depend upon the extent of the tear. A study of the blood supply of that portion of the intestine must be made, and if it is found that the blood supply is seriously impaired, resection of that part of the intestine must be done. The further the injury of the mesentery is from the intestine, the more serious the condition. When such a bleeding point has been secured, a study of the blood supply of that portion of the intestine must be made and the loop of intestine supplied by the ligated vessel excised. When only a short portion of the mesentery is torn from the intestine, say an inch or so, it is permissible to resuture the mesentery to the intestine if the patient's condition is such as not to stand resection. Cases have been reported in which several inches of the mesentery have been torn from the intestine and in which a successful outcome has been obtained by suturing the mesentery in its proper relation and surrounding the gut with omentum. Such a procedure, however, is not advisable in cases which permit excision.

Mesenteric Chyle Cysts.—This condition is very rare. Of the cases reported, 25 were treated by incision and drainage; of these, 23 recovered, 2 died. Of 18 cases treated by extirpation, 12 recovered and 6 died. The result seems to depend not so much on the method of treatment as upon whether a complicating intestinal obstruction is present.

TECHNIC OF EXTIRPATION.—If possible, the mass is delivered through the incision and the peritoneal cavity protected. An incision is made through one leaf of the mesentery—either anterior or posterior, whichever is most accessible—parallel with the intestine and at a sufficient distance to avoid injury to the vasa recta. The cyst is then peeled out. Great care is taken not to injure any of the vessels of the mesentery. All bleeding is arrested, the peritoneal remnants of the mesentery are sutured in place, and the mesentery and intestine returned to the abdomen.

TECHNIC OF INCISION AND DRAINAGE.—The cyst is sutured to the parietal peritoneum and the wound closed up to the attachment of the cyst. After a sufficient length of time for adhesions to form, 2 or 3 days, the cyst is opened. Contrary to expectation, a chylous fistula does not persist and the operation does not have to be repeated.

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THE COLON

CHAPTER VIII

THE COLON

JEROME M. LYNCH

DEVELOPMENTAL RECONSTRUCTION OF THE COLON BASED ON SURGICAL PHYSIOLOGY, AND ANASTALSIS AND THE SURGICAL THERAPY OF THE COLON

DEVELOPMENTAL RECONSTRUCTION OF THE COLON BASED ON SURGICAL PHYSIOLOGY[1]

"Embryological development, extra-uterine growth, and physiological requirements fuse strikingly with other factors to elaborate lesion-characters and symptoms which are not alone typical and peculiar to the colon but essentially constant, easy of demonstration and of paramount vital value. Its origin, its growth and its work, then, must be of trenchant import to all who seek a knowledge of the great gut in disease.

"In the earliest period of development, the vitelline duct or yoko sac, which later may result in Meckel's diverticulum, marks the dividing line between the fore and the hind gut. About the third week of fetal life there appears in the posterior limb of the U-shaped tube a diverticulum which becomes the future cecum and appendix. Thus it is clear that a portion of the small adult bowel is embryologically identical with the great gut, and this explains in a measure the apparent vicarious assumption of colon function by the terminal ileum which will be referred to in the clinical part of this paper.

"Of course it must be understood by all that it is necessary to have a thorough knowledge of the physiology as well as the embryology to make deductions. For, though the organs are allied embryologically, it does not follow that their functions are also closely associated. The proposition we have enunciated does not hold good with organs that are highly specialized, such as the kidney and heart. It applies only to organs that are less highly specialized and older in function, such as the caudad ileum and colon.

"A proper understanding of the various arrests or malformations that may occur in the caudad end of the gut, often resulting in disease, may be obtained by a knowledge of its development.

"About the end of the third month a rotation takes place, and the cecum comes into position over the right kidney. In this, which has been called the second position, it rests until birth when under *normal impulses* it gradually migrates to the right iliac fossa. In the dog, the second position is the final one, and in the light of recent studies in intestinal stasis it may very reasonably be questioned whether man would not have been much better adapted to the upright position and consequently more efficient, had the evolutionary process left his colon in the canine position. Certain it is that the operation of partial colectomy, the technic and value of which have been demonstrated by Bloodgood, and which has given such striking relief in a certain type of toxic cases, is nothing more than a reconstruction of the colon to the second or elemental position. This developmental reconstruction has been done by the authors in 14 cases which afford basis for the clinical deductions presented.

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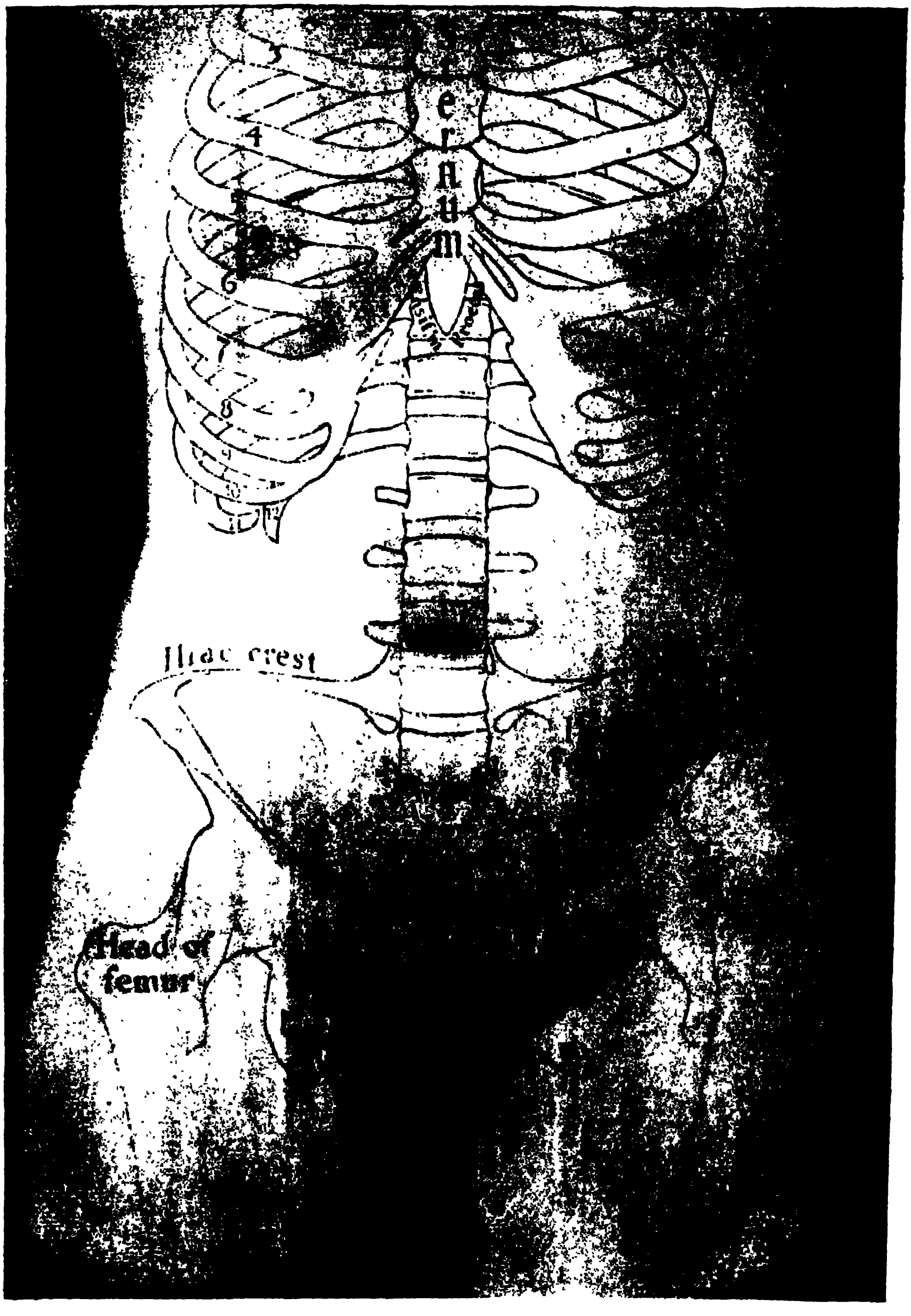
[1] Studies from the Clinic of Gastro-Intestinal and Rectal Surgery of the New York Polyclinic Medical School and Hospital, and from the Laboratory of Physiological Surgery of the New York University Medical School (17).

"Under *abnormal impulses* both the rotation and migration may be aberrant with resulting malformations which are often accentuated by later growth. During the migration the appendix may be caught either posteriorly or laterally. These malformations evidently often lead to functional derangements, with consequent infection, inflammation, ulceration, pericolitis or new growth. In direct sequence may here be cited the clinical history of the J. family. Of 7 children 4 have been operated upon for chronic appendicitis. Of the 3 remaining children, 1 has definite symptoms, 1 indefinite symptoms, 1 has no symptoms. A month ago the mother, aged 64, who had been a chronic dyspeptic all her life, came to an emergency operation and a retroperitoneal purulent appendix was found. This is by no means an isolated instance of the occurrence of appendicular trouble in families and Satterlee has called attention to the hereditary element in ptoses, of which appendicitis is so frequent a complication. This suggests the application to clinical study of the well-known law of heredity that, while acquired malformations are never inherited, the congenital forms are apt to be. In the type represented by the J. family, therefore, an explanation based on hereditary misdirection in the cecal migration from the second to the third position is as reasonable as is the assumption of an hereditary factor in the narrowing of the costal angle, which is an outward manifestation of ptosis, and which has been found accompanying the ptosis cases cited by Satterlee. Rovsing has called attention to the frequency with which the hereditary element is encountered.

"Professor Stockard has furnished us with a specimen of intestine from a man 40 years old. The total length from stomach to anus was 96 inches. Nature had so beautifully maintained the balance in this case, that the circumference was found by measurement to be directly proportionate to the length.

"The *function* of the colon is dual: *elimination* and *absorption*. Elimination is purposely placed first, for the reconsideration of the older physiological teaching has already come to be of great concern to surgery. Brown and Blake and Draper have shown that, in dogs, the doubly excluded and occluded colonic segment will fill to bursting within a few days, even if very carefully cleaned before occlusion. It is thus a pertinent question what to do with partially excluded colonic segments in human beings. Until recently this function seems to have been looked upon chiefly with academic interest. One usually and naturally associates the colon with its most evident function, that of fecal storage and discharge overlooking its fundamentally important attributes. This attitude is not directed particularly toward the colon, but coincides with the general viewpoint regarding other matters of surgicophysiological importance as, for example, the 'biliary' function of the liver and the so-called 'digestive' activity of the stomach. In each the evident and supposedly important function has completely overshadowed the less evident. But the subtle cryptic functions are proving to be the very ones of greatest value to surgery and only through their interpretation can the crude applied art of to-day hope to become the finished science of to-morrow. And we are rapidly learning that only what is biologically true is of fundamental therapeutic worth. Intestinal obstruction is illustrative of this, the only therapeutic measure of any clinical value after a mechanical release of the contents from obstruction having been found through biological studies. This interesting and

3
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little understood condition is also illustrative of the importance of the eliminative function of the colon, it having been demonstrated that, in dogs dying of obstruction, the colon was characteristically hemorrhagic, no other gross or microscopical lesion being demonstrable. This is true also of human beings. Diphtheria toxins, pylocapine, and the metallic poisons are further examples. Indeed, an important corollary from these observations must be that colonic irrigation with or without specific biologic media may be a laudable method of treatment for the conditions mentioned above as well as of obstruction. Indeed, the authors are inclined to believe that the well-known efficacy of continued colon irrigation is effective in large part because of the mechanical washing away of the toxins with which the water comes into direct contact. In many cases of developmental reconstruction of the colon, their patients have absorbed as much as 25 liters of tap water during the first post-operative week. In addition, many liters flowed in and out, thus doubtless effecting direct elimination of toxins. This has been dwelt on by Combe (5). Analogies between the stomach and the colon are familiar, and one may be gleaned by studying the comparative effects of washing out the highly toxic duodenal and gastric contents, which usually accumulate in the stomach after operations on the alimentary canal, and the colon irrigations referred to. In interpreting the efficacy of stomach washing as after morphin poisoning, we are, after all, only traveling where biology points when we assume that colonic irrigation has much the same value as gastric lavage. Further analogies between the stomach and the colon will be alluded to later on.

"The eliminative diarrheas of constipation; of the syndrome called goiter; of nephritis; of syphilis, after the giving of salvarsan, further demonstrate that surgically the colon should be looked upon first as an excretory organ. But animal experiments show clearly that this applies only to the caudad colon. If this be true in the human, as seems reasonable from analogy and observation, then we certainly should hesitate to deprive any individual of so very important a function by the operation of total colectomy, and this irrespective of further metabolic considerations. Surgery, ceasing to be merely an adjunct to medicine, is rightly becoming the active collaborator of chemistry and physiology.

"In studying the absorptive function of the colon surgery has come further to the aid of physiology. Certain new facts of undoubted importance in human therapy have been learned by making use of surgical material, which recent operative procedures have afforded. Any digestive and absorptive function of the colon may naturally be taken on by its embryological prototype, the caudad ileum. Our surgical cases seem to prove this, and these human studies corroborate Cannon's animal findings as to the close physiological relationships between stomach and cecum.

"From a digestive standpoint the stomach and cecum are unimportant. They are both receptacles, and if their motility is not impaired, they normally retain faint traces of digestive functions. The loss of these latter are not felt by any individual if the former is retained. Thus, every observer knows that the objective symptom called achilia gastrica may exist without any subjective symptom developing, provided that gastric motility remains normal. Van Noorden (23) says, 'Protein putrefaction in the stomach reaches a high degree only in the most exceptional cases, and only when both the *secretory and motor functions are completely out of order.*' Theoretically, as just stated, any digestive and absorptive function of the colon should naturally be taken on by its embryological prototype, the caudad ileum. Clinical experience and animal experimentation prove to the authors the stability of this hypothesis, based, as it is, on embryology. Their studies after ileostomy support it.

"It is well, at this point, briefly to review the absorptive and related functions of the colon, as given by physiologists, and then to consider the further details of our researches.

"In a recent paper Hertz says, 'Antiperistalsis does not occur in man under normal conditions: the ileocecal sphincter does not always prevent regurgitation into the ileum. . . . There can be no doubt that the function of the sphincter is, as Keith originally suggested, to prevent the *contents of the ileum passing too rapidly into the cecum.*'

"This function is supplemented by the normal inhibition that is resident in the transverse ileum and can be accentuated under physiological requirements. The preservation, in part or in whole, of this inhibitory segment will, in the future, undoubtedly be an important factor in determining the point at which the ileum is to be cut prior to ileocolostomy. This is supported by our clinical findings.

"Drummond says, 'After ileocolostomy the dilated coils of small gut adjacent to the colon *assume somewhat the functions of the large gut.*'

"Von Noorden states, 'Numerous experiments introducing protein bodies (myosinogen, egg albumen, and casein) into the rectum have shown conclusively that an absorption of natural protein *takes place in the rectum and colon.*'

"Chittenden says, 'In the large intestine . . . the last portions of available nutriment are absorbed.'

"Howell states that when the contents of the small intestine pass the valve they contain a certain amount of unabsorbed food material. 'The food,' he says, 'in this portion of the canal is more or less liquid, and its presence sets up running waves of constriction which, beginning somewhere in the colon, pass toward the ileocecal valve. These waves occur in groups separated by periods of rest. The pressure of the ileocecal valve prevents the material from being forced back into the small intestine. The value of this peculiar reversal of the normal movements of the bowel at this particular point would seem to lie in the fact that it delays the passage of the material toward the rectum, and, by thoroughly mixing it, gives increased opportunities for the completion of the process of digestion and absorption.' This colonic digestion, it is conceded, must take place through the action of the enzymes, which are brought down from the small bowel and which, under favorable conditions, continue their activity in the colon. In this way they estimate that at least from 1 to 7 per cent. of the undigested foodstuffs, chiefly fats, are utilized. Now, if this is so, it means that a patient whose colon is static may lose this amount of food. Sir Wm. Macewen was so impressed by this and by a case that came under his observation that he made the statement that, if the chyme was allowed to escape cephalad to the ileocecal valve, the patient would lose weight, and that under those circumstances artificial feeding should supplement the ordinary diet. Our experience is at variance with this. Not alone is the loss of the normal absorptive function of the colon insignificant, but it is greatly overbalanced by the damage done to the organism through the toxic action of the end products of bacterial proteid dissociation which frequently occurs in the ill-developed, slowly emptying cecum and ascending colon. One characteristic result of this toxemia is mental depression, which may even go so far as to result in mania. Case No. 1832 while at school attempted suicide 3 times; was treated by competent men from a neurological standpoint and was finally operated on by Tuttle with complete symptomatic relief. Case No. 2061 had been imbecile and bed-ridden for a year but recovered after ileostomy. Her debility was so great that the operation had to be done under local anesthesia.

"Case No. 180 (path. No. 2081) presents the following data: Ileostomy, male, aged 30, physician, weight 120 pounds, operated on April, 1912, for relief of acute inflammatory condition of colon with multiple polyposis. Owing to the existence of a common mesentery for ileum and cecum, both were brought outside the wound. Both were opened on the ninth day. Soon thereafter the following observations were made: The reaction of the iliac contents was always acid. The flow of contents was not constant, often being interrupted for several hours. Its consistency varied with the diet; excessive nitrogen caused fluidity; on mixed diet contents was fairly well formed; sometimes very hard when large stick-like movements would be passed. No putrefactive germs, either anaërobic or aërobic, were found. No fecal odor was ever noted. Occasionally the odor was pungent and distinctly unusual. The only enzymes ever present were: amylopsin, a marked; steapsin, a faint trace. Gain in weight, over 20 pounds.

"Another function that physiologists attribute to the cecum and ascending colon is the absorption of water; all the water normally shall have been absorbed when the contents reach the mid-transverse colon. Surgeons have made ample use of these observations in support of various technical procedures, and a careful study of post-operative conditions shows in some cases at least, that their premises or conclusions or both were incorrect. Our studies in the surgical physiology of the parts strongly suggest that embryology and physiology should always precede pathology as a basis for surgical therapy. Indeed, Bloodgood (2), doubtless the best qualified surgical pathologist living, states that the future hope of surgery lies in physiological chemistry.

"Obviously one cannot properly reason from a secondary basis alone, such as is offered by pathology, without having constantly in view also the elemental or primary sciences of embryology, physiology, and chemistry. Without, therefore, a knowledge of the intimate co-relationships that exist between all parts of the body in general and certain parts in particular, applied, or as it is frequently and erroneously called 'practical,' surgery cannot be further developed. Structures of common embryological origin, like the cecum and caudad ileum, may show the greatest possible morphological variation, and yet lend themselves favorably to applied reconstructive surgery when this is done in harmony with both their origin and their function. Thus, the predominant conception to-day that the caudad colon, that is, the part aboral to the mid-transverse line, is capable of vicariously assuming the functions of the cecum and ascending colon as after ileocolostomy, may be correct, but is, in our opinion, incomplete. Surgeons have been led astray by the gross morphological differences between the caudad ileum and the cecum, forgetful of the facultative co-partnership that must just as truly exist between these embryological units as between the morphologically identical portions of the colon. This, at least, seems to us a reasonable basis for explaining the observed interchange of function between the ileum and the colon, which we have herewith recorded. It may also serve to explain the present difficulty in forecasting the end-results after such operations as ileocolostomy. After the implantation of the ileum into different parts of the colon, a persistent diarrhea or constipation has been known to occur. As a general rule, the diarrhea ceases after a short time, but the constipation has proven to be a much more difficult problem to deal with. The explanation of these two facts is now apparent: the vicarious assumption of colonic function by the ileum is almost sure to come; it absorbs water and forms the feces; but the constipation, a pathological condition which existed in the ileum previous to operation, obviously could not be influenced by the mere change of iliac position brought about by this type of operation. It might be influenced, perhaps, as shown in authors' case No. 2012, by the exclusion of the inhibitory segment of the terminal ileum. Here the anastomosis, owing to adhesions, was made considerably oral to the termination of the foregut and, consequently, oral to the inhibitory segment. Indeed, this operation must increase the normal inhibition belonging to the part, thus aggravating the symptom. This increase of constipation has been noted in practice, and is quite distinct from the constipation due to anastalsis, which frequently packs the cecum after ileocolostomy, until its entire removal is necessitated. Lane states that this may be necessary and Patterson places the instance at 5 per cent. or over. It is probably much higher. Careful clinical study along these physiological lines is obviously indicated, so that surgeons may re-adjust their technical procedures upon a sounder basis. The iliac constipation is as yet open only to medical therapy and for this reason every effort at differential diagnosis between the two should be made.

"Hertz presents some facts of interest here. He says, 'An accumulation of chyme occurs in the last few inches of the ileum where it remains and undergoes digestion, actually for a greater period than in the stomach. The normal iliac stasis is increased *in all conditions leading to spasm or to the inhibition of the normal relaxation of the ileocecal sphincter.*'

"Conclusions based on the X-ray alone may lead one into grave error, owing, first, to the fact that röntgenologists are still unable to differentiate between stases due to mechanical and reflex causes, as, for example, between a mechanical kink and an iliac constipation, and, second, to the fact that it has not yet been definitely settled whether bismuth traverses the gut at the same rate as ordinary food, or slower.

"What are our further proofs that cecal digestion is negligible?

"At a certain period of fetal life, as already said, there is little difference between the morphological appearance of the small and great gut. The latter, at first much smaller than the former, contains villi which are later obliterated; the process of obliteration not yet being definitely settled. It is assumed that Liberkuhn's follicles are inverted villi. If so, they may, under the pressure of physiological requirement, revert to the fetal condition and vicariously functionate as villi in fat absorption. But fats must be emulsified before they are fit for absorption, and under the katabolic influence of lipase, which is present in the colon as in all other tissues, emulsified fats may here be digested. (9) In support of this, Tuttle claims to have increased the weight of a patient by the injection into the cecum through a cecostomy of emulsified fats. For the purpose of surgical physiology, however, it appears that the amount of fat absorption in the cecum and ascending colon is of academic interest only.

"Carbohydrate and proteid absorption in these parts occurred in case 180, path. No. 2081, as follows: Grams 30 dry peptonoids were mixed with grams 113.4 warm water and introduced into the rectum at 11 P. M. At 8:30 the next A. M. the bowel was washed out from above with sterile water and the residue examined. Analysis of the peptonoids introduced was as follows (Lab. of Physiology, Cornell University): protein, 39.81; carbohydrates, 50.05; water, 4.72; ash, 5.32.

"Analysis of washings showed that one-half the sugar and nitrogen had disappeared. There was considerable fermentation which probably had a good deal to do with the disappearance of the sugar.

"The nitrogen was in the form of amino-acids. This experiment suggests that proteins in the form of amino-acids may be absorbed from the colon. Normally, however, the amino-acids are absorbed in the small gut only. Under abnormal conditions of incomplete hydrolysis, peptones and other provisional products of protein digestion probably enter the cecum, there to be converted by the proteolytic bacteria into the highly toxic by-products which, directly or indirectly, cause the familiar symptoms of stasis. Combe has called attention to the necessity of removing them by enemata. Adami regards the condition as a sub-infection. Abderhalden has proved that the final product of physiological protein digestion is the amino-acids, having recovered them from the blood. It is clear, therefore, that for the purposes of physiological surgery protein digestion in the colon is as unimportant as it is in the stomach.

"Rectal alimentation has long been a comforting and satisfying therapeutic procedure in the hands of the profession. It was ancient medical history when Hippocrates was a boy. Recent physiological studies, however, show that the hypnotic influence of this old method of vicarious feeding has been at least as great upon the physician as upon the patient. Probably, the good which is conceded may follow it has been due to the therapeutic action of the water and in no way to the food.

"Our medical heritage is almost as rich in bewildering stimuli as our atavistic, which long antedates the batrachians. The one moulds our therapeutic ideas; the other fashions our form. We are encumbered with a faith based upon a horde of inherited misconceptions and the subject of rectal alimentation is only one of the many instances which prove it. Far be it from the province of surgery to set these right; surgeons are not Hamlets, but it is fair to say that the recent rapid progress of colonic therapy has contributed more than any other single factor of the day to endorse reconstructive ideas as well as applied procedures, and to show the pressing need of coöperation between the laboratories of the fundamental sciences and the hospital operating-rooms. The unfriendly attitude existing in the past between physician and surgeon was a misunderstanding arising, as always, from ignorance and is rapidly being put aside. Medicine has evidently been at fault in treating, as in dyspepsia, the peripheral manifestations of some remote insult to the sympathetic system. Surgery, equally undeveloped, was at first simply the emergency tool of medicine, necessarily poor and crude. Gradually light has come from physiology, embryology and chemistry until to-day surgery is able to offer, in selected cases, a therapy which, in removing the cause of disease, often effects a true cure. Such therapy is based on the incontrovertible premise that human beings are normally healthy animals and that for many chronic diseases there is a mechanical cause.

"Intestinal stasis with its long train of protein and distressing symptoms is evidently a common ground upon which physician and surgeon may profitably meet to discuss, without bias or prejudice, the therapy of the future. Whether the developmental reconstruction of the colon herewith described will prove to be of lasting value may, perhaps, be doubted, but one argument favoring its continuance may well be its basis on embryological truths. It aims to correct a congenital deformity and is thus a form of orthopedic surgery. This speaks for its continuance, for the repair of congenital deformities must obviously continue long after the surgery of tumors and inflammations has happily passed away." (17)

ANASTALSIS AND THE SURGICAL THERAPY OF THE COLON

"The physiology and the surgery of the alimentary canal have become so reciprocally interdependent, each alternately correcting the mistakes of the other and showing the way and the need for further research, that it is now idle for either of these branches of medicine to proceed to any conclusions which are not finally and carefully weighed in the scales of the other. Witness the immeasurable effect upon the recent surgery of the stomach by the check of physiology, particularly as regards the subject of so-called drainage and the indications for and against gastro-enterostomy, and, in the immediate present, the interesting reversal of this order of progress in the reconstruction by surgery of many preconceived and erroneous physiological notions regarding the function of the colon.

"It is true that the effect of physiological pressure has been very slow in making itself felt, else there would be fewer individuals suffering from needless gastro-enterostomies, made by the 'practical' surgeon in the bland assurance, as Walter Cannon says, that the human gut is a 'system of rubber tubes conveniently arranged for splicing.' The utter truth of this humorous view has long been a reproach to surgery, and the words of this gentle humorist have rightly carried greater weight with American surgeons than all the tomes of his physiological predecessors.

"Obedient to the law of reciprocal reaction, it now appears certain that surgery will presently return to physiology, in fair exchange for her correcting influences, certain dominant facts regarding the colon which have hitherto been inaccessible to physiological methods of research. It seems, therefore, that the long hoped for and *elysian prospect of a physiologicochemical control of all intestinal operations is no longer utopian, but actually at hand. Certain it is that the sooner there is complete and cordial coöperation between chemist, physiologist, and surgeon, the better for the solution of the bewildering maze of gastro-enterocolonic problems, the very existence of which is only just beginning to be recognized. For no one man can be master of surgical technic and of physiological chemistry as well, and it is progressively evident that the modern surgeon has much to offer his laboratory colleagues in the way of hitherto inaccessible material.*

"*The vicarious assumption of the function of one organ by another in close physiological relationship must be much more common than is usually supposed, and it no doubt affords explanation of the question so frequently asked, as, for example, of the removal of an appendix or a gall-bladder, 'How does the individual prosper without it?' Doubtless,* all the vital functions having long since been taken over by allied organs or perhaps by organs heterologous in morphology if not in function, the loss, by surgical removal of the evident and mechanical functions, such as intermittent storage, was not harmful to the economy.

"While this compensatory power of the human economy is in many cases facultative, it may, on the other hand, as illustrated by the following case, be congenital in type. Lynch has reported (June, 1914, meeting, New York Gastroenterological Society) the amazing instance given to him by Professor Stockard of Cornell, of a human being who reached the age of 40 with only 96 inches of intestine from the stomach to the anus. The significant point in this case, and the one which bears particularly upon the compensation problem under consideration, was that the lumen of the gut was decreased as shown by actual measurements in almost precise proportion to the decrease in the length. This obviously represents an effort of nature to equalize the rate of absorption, and that this was actually achieved is shown by the fact that the individual never suffered any discomfort, was well nourished, and died of intercurrent trouble without any suspicion of abnormality ever having been suggested.

"An excellent operative illustration of the facultative type is probably to be found in the authors' case, No. 988, in which *gradual* intestinal obstruction from ileocecal valve carcinoma, becoming complete, was tolerated for 10 days, the toxic signs being minimized, whereas, after 2 months of re-established function, *acute* obstruction at the same point proved fatal in 3 days, the toxic signs being so fulminant as to cause suppression of liver function and consequent death.[1] Seen in this light, it may well be that such an organ as the colon, for example, may, in certain cases, have so outlived its usefulness to the human economy by vicarious transfer of function as to quite justify its removal. Many of the author's cases collectively illustrate this point; No. 180 specifically so, because after ileostomy formed, movements showed immediately at the stoma, proving that the ileum, previous to obstruction, had already assumed one colonic function. That from birth on, it had no function save that of a catch basin, as intimated by certain enthusiasts, seems harsh and crude—diametrically at variance with every law and precept of biology.

"In studying the authors' series of 8 ileostomies, it is easier to believe in the hypothesis of function transfer from colon to ileum than to presuppose that the colon never had any function save that of storing and distributing toxic material. The gross clinical observations on this series of ileostomies alone will be given. In each patient there was a marked gain in weight, the fecal movements from the ileum were always solid, and the reaction was always acid. What could offer a more direct reversion of the older teaching of the physiology of the ileum?

"Consider this question of colonic therapy from another viewpoint. If the organ has a function vicariously transferred for the time, how can we be certain that after a restitution of normal conditions, there may not properly exist an impulse to restore to the colon whatever functions it may have parted with under stress of weather? Such functional restoration has been noted by Satterlee in studying a large number of cases of watertrap stomach. It has been found by him little short of amazing to note the rejuvenation of the function of the gastric mucosa after surgical replacement of the organ, and this is particularly so because no gross morphological change was noted in the mucosa at time of operation.

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[1] Draper. Studies in Intestinal Obstruction, Jour. Am. Med. Assn., Sept. 26, 1914, lxiii, 1079-1082. See Tables I and II.

"Potential as these queries necessarily must be, they are given kinetic value by the fact that out of any number of persons undergoing total colonectomy, a large proportion will die from the immediate effects of the operation. Whatever the vital function of the organ, it is, therefore, obviously better to retain it in situ, either in whole or, under certain conditions of duodenal dilatation as described by Bloodgood, in part; *provided that suitable provision be made for emptying the organ at its oral extremity.* It seems to the writers as inappropriate to speak of cecal 'drainage' as of stomach 'drainage,' since, as shown by one of them (Draper: Studies Surg. Lab. Columbia, i, 1907), as well as by numerous X-ray observations, no drainage of the stomach occurs from its most dependent part, except when the organ is temporarily paralyzed, as in the dilatation of the last stages of pyloric obstruction, because the *emptying occurs directly in line with the peristaltic waves, and not at right angles to them.*

"From a study of a considerable number of cases of chronic colonic constipation, the writers are convinced that there is a well defined group in which the constipation is due to preponderance of the anastaltic over the prostaltic colonic wave. This is easily shown by the rapid transfer of a bismuth enema from the rectum to the cecum and the return to the rectum of a portion of the mass—some remaining in the cecum—the round trip occupying about 6 to 8 minutes. The haustral segmentations are not affected; the return to the rectum is slower than to the cecum: gradually the bulk of the mass accumulates in that organ, and the reciprocal movement ceases.[1]

"If, as we believe, there is this form of anastaltic constipation associated with coloduodenal dilatation and insufficiency of the ascending colon, and which can be easily diagnosed by the X-ray, it is evidently due to aberrant physiology rather than to faulty morphology, placement, or other mechanical conditions, and must be treated by a physiological rather than morphological method.

"Anastalsis is, therefore, necessarily a most important factor in colonic therapy, for all observers are agreed not only as to the frequent existence of the anastaltic wave throughout the colon but also as to its preponderance over the prostaltic wave in the group considered.

"It is not yet agreed in what exact percentage of cases this preponderance occurs, but it is assuredly so large as to constitute the most urgent problem yet to be solved in the operation of ileocolostomy. This is positively demonstrated, not alone by several of the authors' cases, but by the actual postoperative clinical findings of those surgeons who are doing this operation most frequently. Patterson asserts that fully 5 per cent. of ileosigmoidostomies require colectomy at a subsequent date because of the packing and progressive dilatation of the partially excluded and occluded segment. It has been shown by the studies of surgical physiologists[2] that a totally occluded bowel will fill to bursting with fecoid material in a very short time, and that incomplete exclusion results in the so-called 'policeman club' dilatation, which, if untreated, results in terminal perforation.

"Now, as is well known, the small gut possesses normally but one—the prostaltic wave. Upon this fact are based 2 of the methods of surgical therapeusis outlined below.

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[1] Observations on authors' cases by L. T. LeWald.

[2] Brown Blake Studies on Exclusion.

"Draper, in unpublished studies from the Mayo Laboratory of Surgical Chemistry and Physiology, Rochester, Minn., has shown that circular segments of ileum may be transplanted into the colon without undergoing any gross morphological change. This has also been demonstrated by others. In each of these instances, however, the transplant was designed to bridge a gap in the sigmoid following resection for malignant growth, the operators making no mention of the possible important physiological therapeusis of this procedure. It is evident, however, that such a ring of ileum would serve to block the colonic anastaltic wave and should prevent the return of material to the cecum. Halsted was the first to record experimental studies in gut reversal, and we know from his work, and from that of later observers, that solid materials have a tendency to collect at certain points if the course of the waves is broken, and this tendency might or might not be a factor limiting the value of the blocking method suggested.

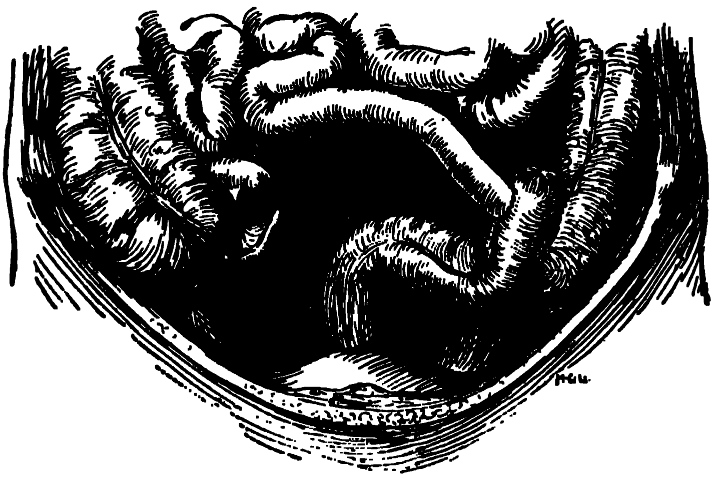

FIG. 1.—ILEOSIGMOIDOSTOMY SECTION AND OVERLAPPING OF SIGMOID TO BLOCK ANASTALSIS. The cephalad current will not pass through the stoma as the emptying occurs directly in line with the peristaltic waves, and not at right angles to them. (Lynch's operation.)

"In the presence of a sufficiently strong wave there might, therefore, possibly be developed a tapering colonic dilatation immediately aboral to the transplant. This, however, does not occur in the authors' experience with this procedure in animals.

"The physiological hypothesis which should explain the failure of cecosigmoidostomy may perhaps be found in the fact that the current is distaltic or oscillating. The ileac segment, which is made of proper length to reach comfortably from the cecum to the sigmoid, is slipped up on the ileum and united throughout about half its length. Terminally the aboral ends are sutured together so that a circle results. The effect of this technic is virtually the production of a double-barrel gun, and the end-to-side implantation into the sigmoid is thus converted into a single procedure. The oral extremity of the segment is then inserted into the oral extremity of the cecum. Material is in this way able to pass from the cecum to the sigmoid, but cannot reverse its direction. The oscillating distaltic wave is made constant or monostaltic.

"Figure 1 shows a very simple method of preventing anastaltic reflux after ileosigmoidostomy. This operation is performed after the usual technic. After the anastomosis has been completed, the sigmoid is divided between clamps, and by means of a cautery immediately oral to the anastomosis. The aboral end of the sigmoid is invaginated after the usual manner, and the oral end slipped down beside the aboral limb until the oral extremity is several inches below the ileosigmoid anastomosis. The operation is completed by a terminolateral anastomosis." (6)

SURGICAL ANATOMY OF THE COLON

The large intestine is that specialized part of the intestinal canal concerned in the churning of the remnants of food, absorption of water and the formation and evacuation of feces. It has other physiological functions, but they are of minor importance.

The colon begins in a dilated pouch, the cecum; and ends in a dilated pouch, the rectum. Its entrance is guarded by an automatic valve, the ileocecal; its exit by a valve under the control of the will, the anal sphincter. It is widest at the cecum and narrowest at its junction with the rectum. Four anatomical angulations give this organ potent pathological possibilities.

Dissected free from the other organs and its angles turned into curves, the colon forms an incomplete circle, the gap being on the right side of the pelvis between the cecum and rectum. In the normal position, however, it forms a square, incomplete in the pelvis, enclosing the small intestines very much like a frame around a bas-relief. Three gross features distinguish the large from the small intestine. They are (a) the teniæ coli, (b) the appendices epiploicæ, and (c) the colonic saccules. The teniæ coli are longitudinal muscular bands, and are a structural conversion from the longitudinal muscular layer of the small intestine. There are 3 of them, all beginning at the base of the appendix and arranged, 1 anteriorly and 2 posteriorly. In length they are about 1/6 shorter than the colon. Because of their disposition, the posterior bands are denominated postero-internal and postero-external respectively. A characteristic change in the course of these fibers occurs in the transverse colon and rectum.

The appendices epiploicæ are small pouches of peritoneum containing tabs of fat. They are found throughout the course of the colon, principally along the anterior bundle of the teniæ coli, and projecting from the serous coat of the colon. They are very much diminished in size or absent in emaciated subjects. According to Cunningham, the appendices epiploicæ can be distinctly seen as early as the seventh month.

The colonic saccules are pouches in the wall of the colon, and are produced by the inequality in length between the teniæ and the other coats of the intestine. If the teniæ are dissected away, the sacculation disappears.

Fundamentally the structure of the large intestine is much the same as that of the small intestine. The chief points of difference are the presence of the teniæ coli and the absence of villi in the large intestine. The peritoneum invests it completely in its transverse and pelvic divisions. The cecum, too, is almost always invested by peritoneum. The ascending, descending, and rectal divisions are only partly ensheathed in peritoneum.

Its mucous surface is smooth and of a pale color, becoming redder as the rectum is approached, where it takes on special characteristics which will be described in connection with that region.

Apropos of the mucous membrane of the colon, the ileocecal valve is a subject of considerable interest. Primarily the ileocecal valve is a slit-like opening, with 2 protuberant lips, which project into the lumen of the colon at its inner and posterior border and at the upper border of the cecum. It is composed *of all but the serous and longitudinal muscular coats of the intestines. Its direction is anteroposterior, and it is a little over 1 cm. in length. Its 2 surfaces are different; for the one looking toward the ileum is covered with villi, whereas the one toward the colon more closely resembles the mucous membrane of that structure.* The mechanism of this valve depends upon 2 characteristics, first upon the direction of the ileocolonic junction, which is rather an obtuse angle, and second, upon the fact that when the cecum is distended it tends naturally to put the frenulum on the stretch and thus shut off its lumen. To locate this point on the body surface, draw a line from the highest point of one iliac crest to the other. Draw another line upward from the midpoint of Poupart's ligament on the right side. The intersection of these 2 lines marks the normal location of the ileocecal valve.

By reason of its peritoneal attachments and arrangements, the colon is divided into: Cecum, ascending, transverse, and descending, iliac, pelvic, and rectal colon. The individual parts, while they have a good many features in common, still present enough anatomical, surgical, and pathological differences to be considered separately. Also, the physiology of the colon is the same in all its parts.

Primarily the cecum is a blind pouch. Into it open 2 orifices. One of these is from a blind tube, the appendix; the other is the ileocecal orifice from the small intestine. It is the first region of reception of the contents from the small intestine, and the last point in the colon to check backward pressure of fecal contents. Besides, it hangs free and is capable of enormous distention. Thus it becomes a center of surgical, anatomical, physiological, and pathological interest. When distended to the point of bursting, and left attached to its mesentery, it is seen to be an unsymmetrical pouch, curving over internally; on its anterior surface it is made tense by the anterior teniæ coli; and is longer at its antero-external surface and external border.

INSTRUMENTS USED IN OPERATIONS OF THE COLON

8 retractors.
1 Child's intestinal forceps.
3 knives.
5 thumb forceps.
4 scissors.
1 needle holder.
4 straight intestinal needles, threaded with fine iron-dyed linen.
4 curved intestinal needles for the fascia.
2 strong, round curved needles for the peritoneum.

1 straight spear-pointed skin needle.
2 intestinal forceps.
10 towel forceps.
8 Sands forceps, small and large.
15 Lane's clamps.
8 small artery forceps.
2 hemorrhoidal clamps.
2 drainage tubes.
1 cautery.
1 volsella.

OPERATIVE PROCEDURES

ELEMENTAL RECONSTRUCTION OF THE COLON, OR RESECTION OF THE FIRST PORTION OF THE LARGE INTESTINE

Removal of the first portion of the colon with 3 or 4 in. of the ileum may be performed for malignant growths of the cecum or colon, or for a number of other conditions, such as ptosis of the cecum with a movable and non-fused first portion of the colon.

Resection of the first portion of the large intestine may be simple or difficult, depending upon the condition for which it is performed and on the fixity or mobility of the colon. As shown by Sargent and Dudgeon, if a malignant tumor involves the first portion of the large intestine, complete removal of that section of the lower bowel is indicated, on account of the lymphatic distribution. Figure 4 shows the first portion of the large intestine with its blood supply, the subsequent anastomosis, and after it has been anastomosed.

Indications.—Bloodgood believes that where the cecum is markedly ptosed and fixed in the pelvis, removal of the first portion of the intestine is indicated. He believes that the pull on the mesentery of the small intestine causes kinking of the jejunum with dilatation of the duodenum. I believe, with Bloodgood, that the operation is indicated under such circumstances, but I do not think that the ptosed and fixed cecum can cause kinking of the jejunum. The dilatation of the duodenum, I believe, is a result of a toxemia from stasis, rather than from any mechanical condition. I have removed this portion almost a dozen times, and am perfectly satisfied that, under ordinary circumstances, it is an operation that should have a very low mortality, except in cases of malignant growth. When operating for malignancy, I believe that the operation should be performed in several steps: First, the relief of the obstruction; second, resection of the growth; and third, anastomosis. This is especially important in old people, and I am convinced from my experience that it pays to divide the operation thus. This operation is also indicated in cases of auto-intoxication associated with nonfusion.

Technic.—The technic which I have adopted is as follows: the patient is prepared very carefully for operation by thorough catharsis and warm bath the night before the operation. The abdomen is washed off with alcohol, and a sterile towel is held in place by some adhesive strips. When the patient

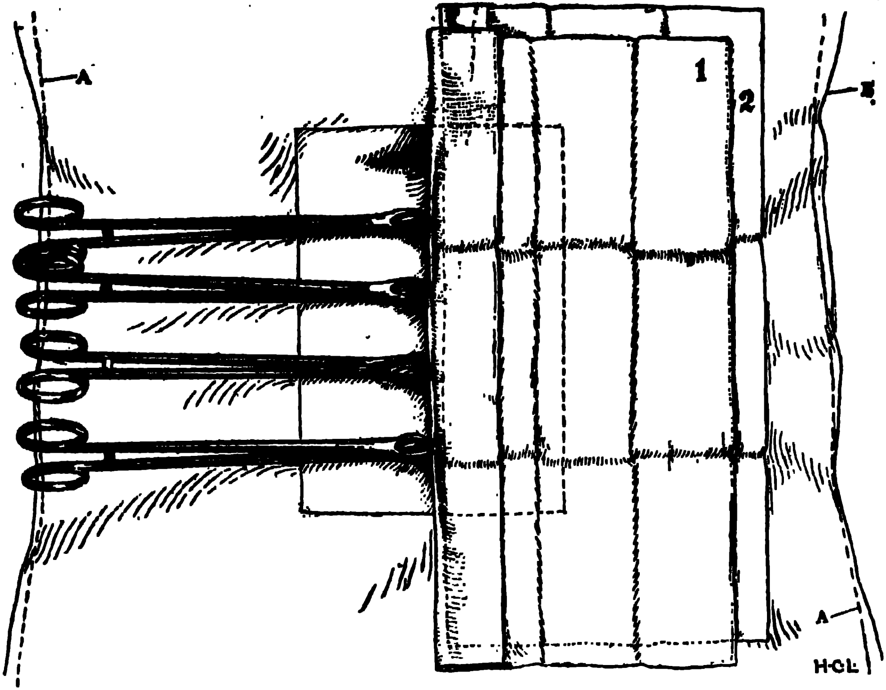

FIG. 2.—THE METHOD OF ATTACHING TOWELS TO THE EDGE OF THE WOUND. Towel 2 in place; towel 1 has not yet been turned over.

is on the table, the abdomen is painted with tincture of iodin, 5 per cent. If the skin is tender, the iodin is washed off immediately with alcohol.

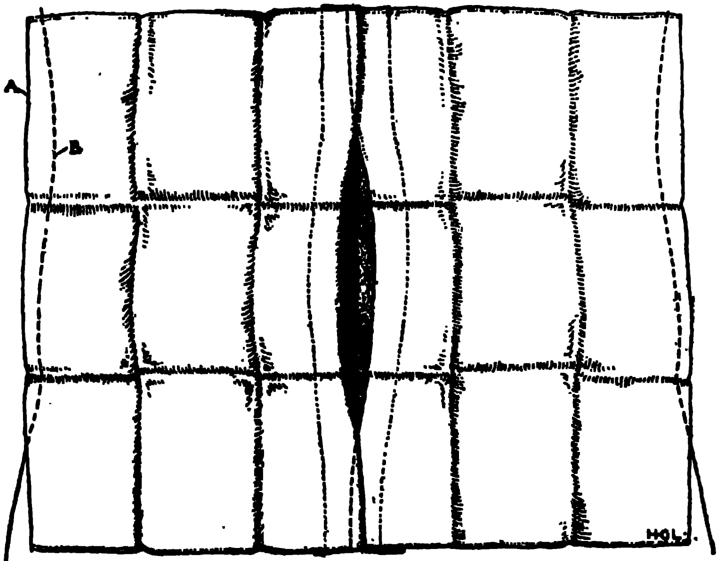

FIG. 3.—TOWELS SHOWN IN PLACE AFTER ADJUSTMENT OF THE CLAMPS.

The incision depends a great deal on whether the patient is very stout or thin. In obese individuals I am in the habit of making an incision just outside the outer edge of the rectus. In thin individuals I make an incision just outside the median line, through the rectus, beginning about 2 in. above the umbilicus, and continuing for the same distance below the umbilicus. This incision can be extended in either direction; if the stomach and gall-bladder require manipulation, it is extended upward; if there is any pathology in the pelvis, it can be extended downward. If the first incision has been made down to the fascia, the skin is carefully covered with sterile towels, attached to the lips of the skin by means of Lane's clamps. When the towels are in place, the incision is continued until the peritoneum is opened. We now follow a definite plan in exploring the abdomen. We begin by examining the cecum and ascending colon; then the gall-bladder, liver, stomach, and its pylorus; next the transverse colon, the sigmoid, and pelvic organs, and so on.

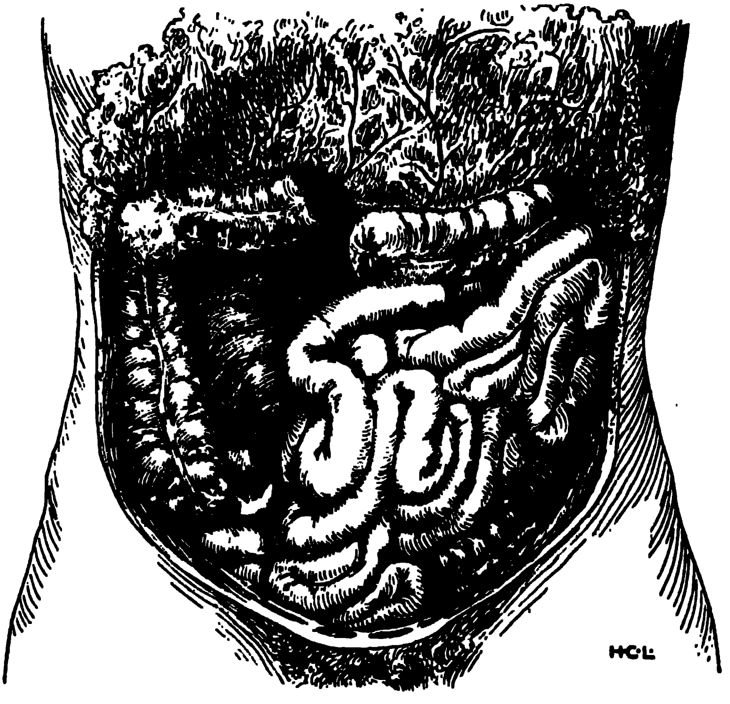

Fig. 4.—Showing Blood-vessels to be Tied Before Removal of the Colon.

Having decided to remove the first portion of the large bowel, it is brought outside of the abdominal cavity, and everything else is carefully packed away, so that during the entire operation there is no exposure of any of the other organs. I believe that my success with the operation, so far, is entirely due to the careful technic I have adopted. The rest of the bowel having been care-

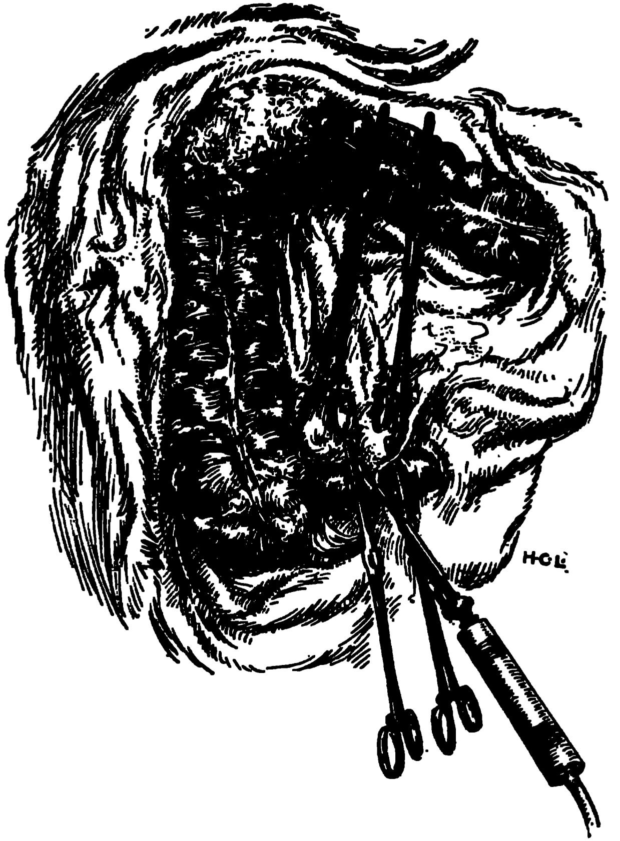

Fig. 5.—The Lynch-Draper Method of Removal of the First Portion of the Colon, Showing the Clamps in Position and the Ileum Being Divided by the Cautery.

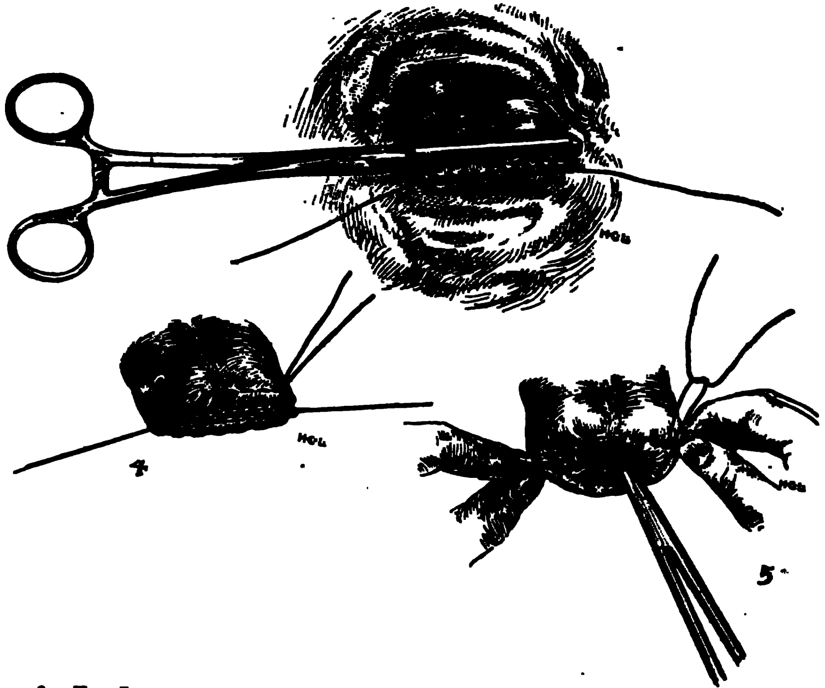

Fig. 6.—The Lynch-Draper Method of Treating the Stumps after the Bowel Has Been Divided. 3, 4, and 5 show successive stages in this procedure. (In 5 the drawing is not quite correct. Before inverting the stump, the bowel is held in place by the purse-string suture, and not, as in the illustration, by steadying the bowel with the fingers.)

fully packed off, the outer leaf of the mesocolon is slit close to the bowel, beginning at the cecum and continuing to the hepatic flexure. After this has been accomplished, the colon is mobilized, so that the subsequent steps are perfectly simple.

When operating for a malignant tumor, the subsequent steps of the operation are slightly varied. The same technic is followed, in that both leaves of the mesentery are split, and everything between the 2 leaves of the mesentery is scooped out.

When operating for a marked mobility owing to non-fusion, the blood-vessels are tied pretty close to the bowel, whereas when operating for malignant tumor they are ligated as far from the bowel as possible. All blood-vessels having been tied (Fig. 4), and the colon separated between the transverse colon and the ileum, 6 in. from the cecum, we proceed as follows: The transverse colon and ileum are double clamped, and the bowel is divided by means of the cautery (Fig. 5). The oral and aboral ends are now treated in the following manner: The stump in front of the clamp is closed by means of a Moynihan suture (Fig. 6, 3). Before removing the clamp, a purse-string suture is taken in both ends of the bowel, about ½ to ¾ in. posterior to the clamp (Fig. 6, 4), and the stump of the bowel is inverted (Fig. 6, 5). The ileum with its mesentery is brought in contact with the transverse colon and fixed in position by 2 sutures (Fig. 4). Underneath the ileum and colon a roll of moist

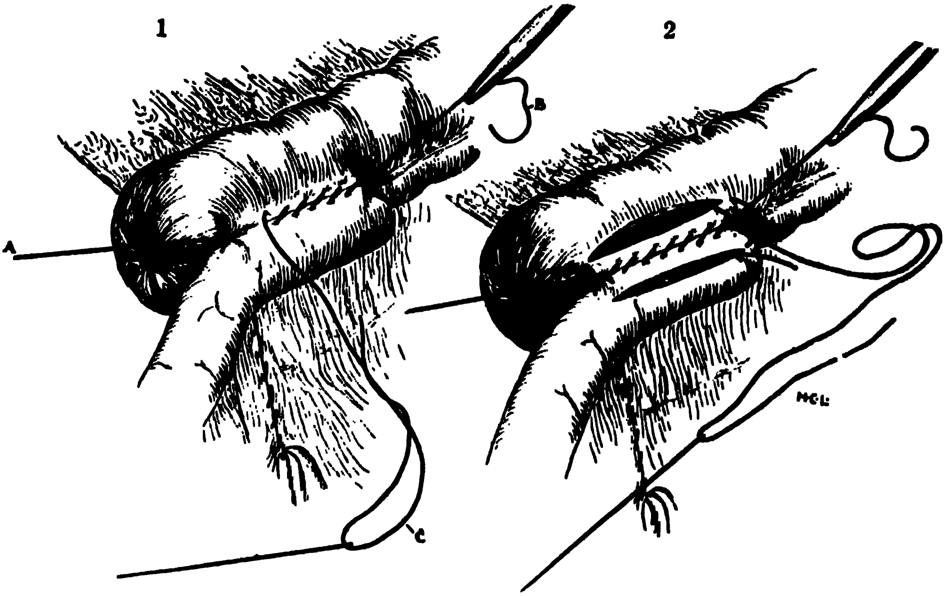

Fig. 7.—The Lynch-Draper Method of Anastomosing the Ileum to the Colon and Our Method of Closing the Hiatus in the Ileocolic Mesentery.

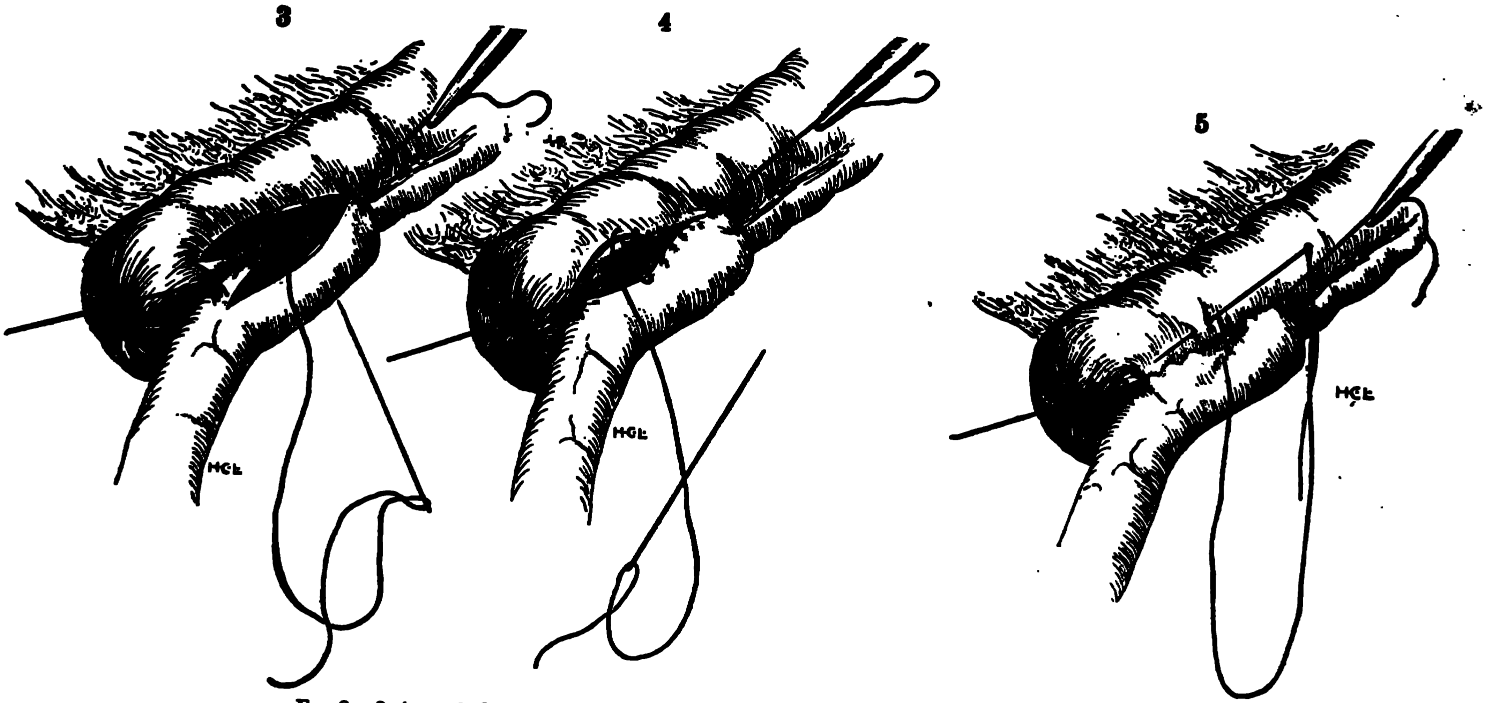

FIG. 8.—3, 4 AND 5, SUCCESSIVE STEPS OF AN ANASTOMOSIS BETWEEN THE ILEUM AND THE COLON.

gauze is placed and the 2 parts to be anastomosed are carefully walled off with gauze.

The rest of the operation proceeds in an orderly manner, beginning with a seromuscular suture (Fig. 7). The next step is accomplished as follows: An incision is made into the ileum about ⅛ in. from the first row of sutures (Fig. 7, 2). This incision is carried through the mucous membrane into the bowel. There is occasionally some bleeding at this point, but it is hardly ever necessary to ligate blood-vessels, as the next step is sufficient to control any hemorrhage. The next step begins as in Figure 7, 2, by first picking up the mucosa, coming out through the serosa, passing in through the serosa, through the mucosa and out again. After this the first suture is tied, holding the serosa in apposition. This suture is continued as indicated in Figure 8, 3. For the final closure, I prefer a modified Connell suture (Fig. 8, 4). This suture is usually sufficient in all cases, but if there is any doubt in the mind of the surgeon, he can cover this Connell suture with a Lembert suture (Fig. 8, 5). The material used for all intestinal work is fine iron-dyed linen.

Figure 9 shows a diagram of the anastomosis completed.

After the final suture, all soiled pads and instruments are removed, and the operator changes his gloves before removing the inner pads, so that there is no chance of subsequent soiling from any pads or instruments that may have been in close association with the bowel during the anastomosis.

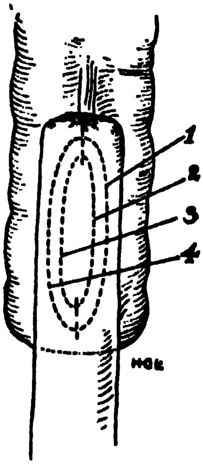

Fig. 9.—Diagram of Completed Anastomosis. 1 and 2 show the lower line of sutures; 3 and 4 the upper.

We always fix the stump of the colon to the peritoneum. We believe this is good policy, as it holds the anastomosis in position and assists drainage of the transverse colon. If allowed to recede back into the abdominal cavity, it might become adherent at some unusual situation and interfere with the passage of the chyme from the ileum to the colon.

POSTOPERATIVE TREATMENT OF COLONIC RECONSTRUCTION

The after-treatment of developmental reconstruction of the colon is as important as the operation. It is determined by differential diagnosis. It is based upon physiology. In case of severe postoperative reaction, the operator may feel alarmed by the constant vomiting and very rapid pulse which occasionally are met with here, as after any other major operations on the alimentary canal. These symptoms, in brief, are usually nothing more than manifestations of acute dilatation of the stomach, which invariably yields to energetic treatment.

By persistent stomach washing (every 4 hours or oftener); by the use of a continuous Murphy drip; and the judicious use of whisky, seemingly hopeless conditions may be arrested; the patient tided over and enabled to make an excellent recovery. We mention this as a word of warning to those not familiar with the train of symptoms we have cited. Hydrotherapy is the never-failing mainstay here, as after all other gastro-intestinal operations. Vigilance and persistence in the treatment we are about to outline must not be relaxed, even in the face of a most discouraging outlook, until the patient has had a movement of the bowels and has taken food.

Since our technic has improved, and since we have confined ourselves to operating only in instances of mobile cecum and ascending colon, we have had relatively little reaction following this operation.

In the last series of 5 patients operated on under like conditions 3 had no more reaction than from an ordinary appendectomy, while 2 had an exceedingly stormy time. We have found it very difficult to forecast the character of the postoperative convalescence, but it may be added that this is true also of other major operative procedures.

The convalescence may be divided into 3 periods: The first 40 hours is apt to be one of quiescence. The second 40 hours may or may not be stormy. After the 80th hour the crisis is usually past.

It is during the second period that good judgment and sound surgical sense count for everything. One may be called upon to make differential diagnoses upon which will depend the life of the patient. A specially trained and highly intelligent nurse is essential.

By way of concrete illustration the following 2 cases may be cited:

E. L. K., Case No. 4710.

Chronic disabling epilepsy shown by prolonged medical treatment to be probably of colonic origin. Cecum and ascending colon found at operation to be enormously dilated. Elemental reconstruction of the colon seemed indicated and was carried out after the Lynch-Draper technic. At the 33d hour the pulse rose to 130; lost quality and patient became very restless. The temperature rose to 101°; severe pain; vomiting "light-struck silver nitrate" material, slightly feculent in odor. 40th hour: calomel gr. i in divided doses; pain increased. 50th hour: marked and fulminating increase in symptoms; abdomen not rigid, soft, very moderately and uniformly distended; bowels moved slightly 3 times, with flatus; pulse remained at 130, becoming irregular. 70th hour: patient unable to sleep because of being roused by violent uncontrollable cramp-like pains. 72d hour: wound opened; obstruction of small gut by band; fluid passed anastomosis freely when obstruction was removed. Death in 12 hours.

Mrs. F. H. B. Case No. 4718.

Chronic invalidism, suicidal tendency, occasional loss of memory, inability to concentrate, mental depression, disabling occipital headaches, cutaneous eruptions, very severe constipation relieved only by the most drastic purgatives, 10 years of intelligent medical treatment.

X-ray was suggestive of a static ascending colon. Operation revealed a very redundant transverse colon; ascending colon bound down by typical fan-shaped diaphanous adhesions, the fan handle originating in the parietal peritoneum close to the duodenum, radiating mesoventral to the colon. The central fibers of this membrane, denser than the rest, crossed the colon oral to the hepatic flexure, causing partial obstruction. Immediately on liberating this membrane the cecum and ascending colon flowed out freely through the wound, showing that a congenitally mobile organ had become fixed by adhesions. Glands thickly studding the mesentery suggested a probable inflammatory origin for the diaphanous membrane and afforded justification both for ascribing the symptoms to colonic toxemia and for resection as well.

Elemental reconstruction of the colon by the Lynch-Draper technic.

Except for considerable pain the first 40-hour period was uneventful. At the 50th hour the pulse in 10 hours rose from 80 to 120; quality remained good; pain over wound; normal amount of postoperative gas as shown by slight distention. At the 55th hour stomach washing returned pea-soup-like material, sour, non-fecal in odor; neither gas nor fecal flocculi in colon washings. 60th hour: stomach washing showed only slight froth; no nausea; restless and noisy at times but progressively stupid and drowsy. 50th to 60th hours: facies pinched; chest negative. 60th hour: stomach washings becoming feculent in odor; skin, wet, cold and clammy; hands cold; feet warm. 55th hour: blood differential count showed total leukocyte 13,000; polys, 87 per cent.; small lymph, 9 per cent.; large, 4 per cent. Differential diagnosis was obviously between peritonitis, mechanical obstruction and physiological obstruction, with acute dilatation, postoperative shock and hemorrhage being evidently ruled out.

Nursing orders at this time were as follows:

(1) Eserene gr. 1/60, 3 doses.
(2) Sugar-of-milk calomel, 1/10 gr. doses No. X.
(3) Morphin gr. 1/30 p.r.n.
(4) Stomach washing, q. 4 hrs., oftener, if nausea or gulping hiccough, and followed by Seidlitz powder.
(5) Colon irrigation: flush by siphon—1 liter tap water at 130° F., q. 1 hr., gtt. 40 per minute between flushings. (This very important part of the treatment is based upon the mechanical washing away of toxins eliminated by colon; in part for absorption of water.

At the 65th hour the blood-pressure was 116, the differential count total 14,400; polys, 80 per cent. Treatment continued. Some gas and flocculent material continued to pass. At the 80th hour patient had 3 bowel movements in quick succession, after which there was uneventful convalescence.

Certain facts are self-evident from a study of these 2 cases. The reconstructive operation of the colon is fraught with danger and should be considered an operation of necessity rather than of choice. When necessary, it should be performed only by surgeons experienced in the surgery of the alimentary canal.

The general after-treatment of the first 40 hours is as follows:

After the patient has been returned to bed, a Murphy drip is started immediately. We use tap water at a temperature of 130° F. in the reservoir, steadily maintained by an automatic electric rheostat. Adults, particularly if the tissues are desiccated, as is the usual condition, receive 60 drops to the minute; others proportionately less. Every hour the drip is discontinued, the colon is filled and then all the water is drained off. This mechanically removes the toxins. It, incidentally, in our experience, is the essential treatment for gas pains.

The stomach is washed out at the end of the operation, and, if there is any gastric irritation manifested by a peculiar, irregular gulping hiccough, or by nausea, gastric lavage is immediately instituted and renewed every 4 hours or oftener until gastroduodenal peristalsis is established. Draper and I have observed this abortive hiccough so constantly that we now regard it as pathognomonic of an acutely dilated stomach.

The contents of such a stomach are characteristic and resemble nothing so closely as an old solution of light-struck nitrate of silver. Nothing is given by mouth for the first 48 hours except a little cracked ice. If the patient suffers severe pain, and this is to be expected, morphin is administered, but great judgment should be exercised in giving it, as the symptoms of intestinal obstruction may thus be masked. It is well to use doses of 1/30 gr. as taught by Halsted. Severe pain with a rising pulse, tending later to intermit, is suggestive of intestinal obstruction. This, however, should not be mistaken for the progressively rapid pulse of severe hemorrhage. In either case, the patient should be operated on immediately.

On the third day calomel is given in broken doses of 1/10 of a grain. This is followed by oxid of magnesia.

Simple solid food is given if indicated on the third day.

RESECTION OF THE TRANSVERSE COLON

Resection of the colon is attended with some danger on account of scant blood supply and the possibility of leakage, especially with an end-to-end anastomosis. This is particularly so if the ends are brought together under tension. We have in mind, of course, resection for a malignant tumor, and under such circumstances a wide removal is necessary, if one wishes to avoid a recurrence. Fortunately malignant tumors do not occur very frequently in the transverse colon, and when they do occur there, they are frequently secondary to a tumor of the stomach or some neighboring organ, and are usually beyond surgical intervention. Mayo, in his Clinic, 1912, says: "Generally speaking, malignant disease in any part of the large intestine proximal to the transverse colon is treated best by removal of all the large intestine up to and including the growth, doing an ileocolostomy. Beyond this point resection in continuity, either in one or two stages, is preferred. If obstruction is or has recently been present, the two-stage operation is much safer."

RESECTION OF THE SIGMOID

Tuttle's Three-step Operation.—An incision is made outside of the left rectus muscle. It should be about 4 in. long in order to give plenty of room for subsequent manipulations. A self-retaining retractor is fixed in place, the patient put in the Trendelenburg position, and the small intestine walled off. The sigmoid is brought out of the abdomen and the peritoneal covering of the mesosigmoid slit along for a distance well above and below the tumor and peeled back to the posterior abdominal wall, exposing the blood-vessels and the surrounding tissues and glands, loosening the attachment of the gut and allowing it to be brought out upon the abdominal wall. The blood-vessels supplying the part of the bowel involved in the growth are exposed by pulling or milking away toward it the surrounding glands and fatty material. The artery and veins can then be seen clearly, and the main vessel supplying the involved portion is cut and tied in 2 places (Fig. 10). The gut is thus loosened and can be pulled freely out of the abdominal cavity. The stump of the blood-vessel is pushed back between the 2 peritoneal layers of the mesosigmoid, which are then stitched together, covering up all the denuded surface in the peritoneal cavity. The 2 legs of the loop of the sigmoid are now brought together by 1 row of sutures running along the border of the mesentery and well within the peritoneal cavity, and then by another row taken for the same distance through the long muscular bands. Two flat surfaces of the bowel are thus approximated. (Fig. 10.)

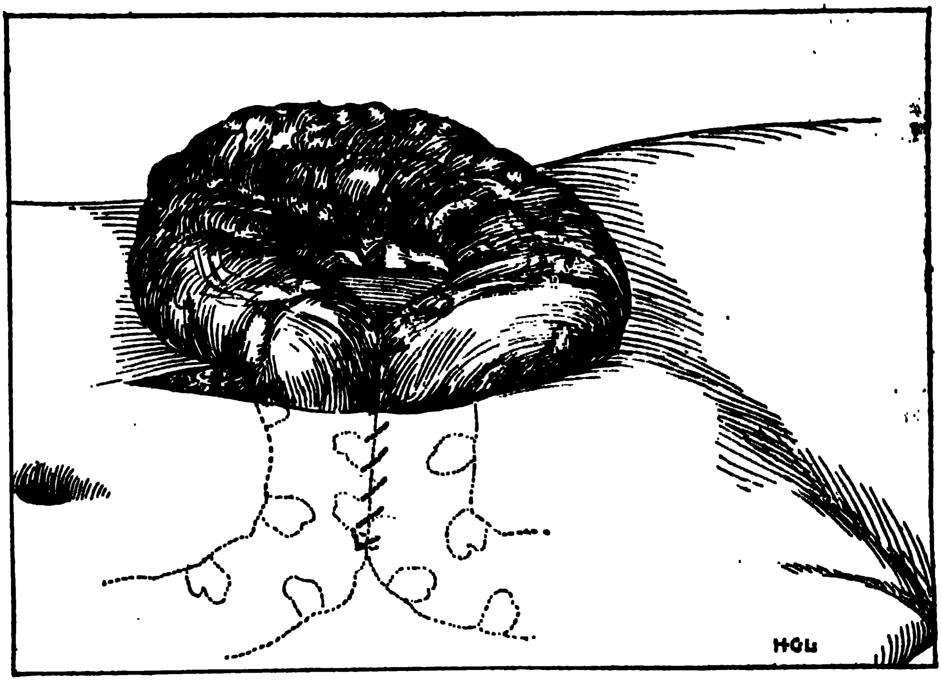

Fig. 10.—The First Stage of 3-Step Operation.

With the tumor well outside the abdomen, the peritoneum and then the skin are stitched about the 2 legs, and the whole is covered with rubber tissue and left *in situ* from 24 to 72 hours, according to the condition of the patient. If there is any indication of obstruction, a puncture can be made in the upper leg, allowing gas to escape; or if gangrene should be imminent in the exposed loop, there is no reason why it should not be excised any time after 18 hours, or even less. The growth can be, and has been, removed at the end of 20 hours, when necessity demanded, without any complications. When the gut is excised, it should be done by a V-shaped incision, as in Figure 11, so that there may be abundant material for bringing the ends together later.

It will be observed that, since the main blood-vessel supplying this loop has

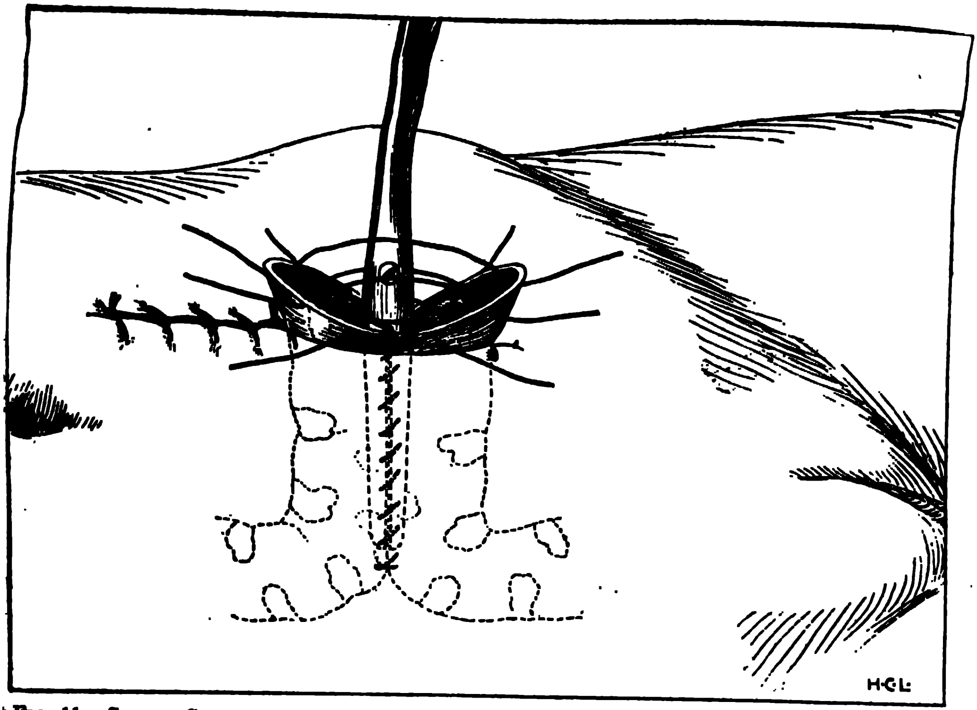

FIG. 11.—SECOND STAGE OF 3-STEP OPERATION. Method of dividing the septum between the two ends of the bowel by means of a clamp.

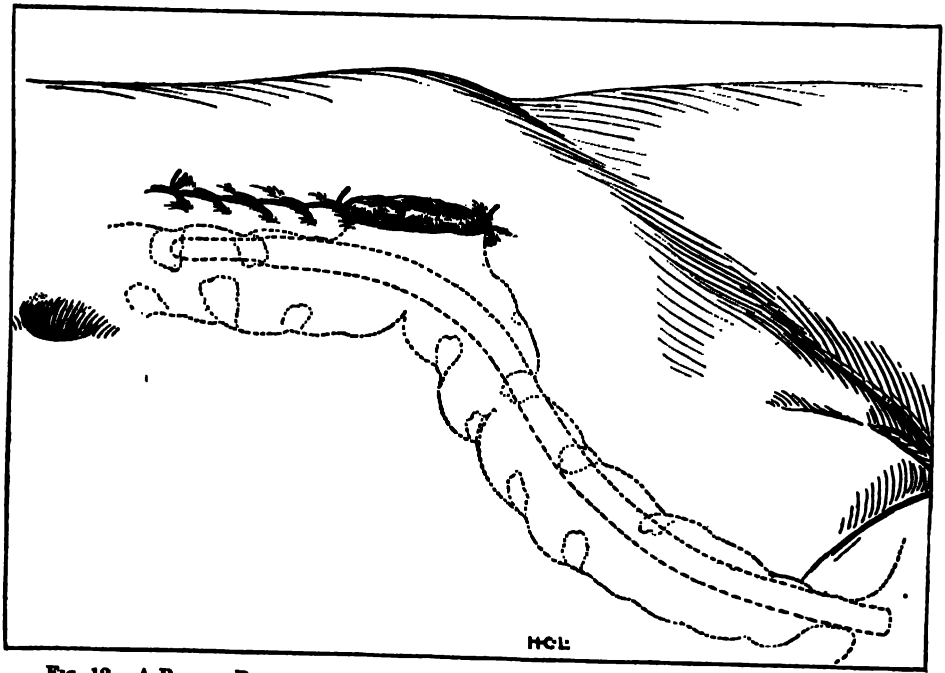

FIG. 12.—A BOUGIE PASSED THROUGH THE RECTUM AFTER THE SEPTUM HAS BEEN DIVIDED.

been ligated, there will be little or no hemorrhage and no pain in the resection; and there is no danger of peritoneal infection, as this cavity will have been closed off after the first 5 or 6 hours. Almost a week should elapse before the clamp is put in to cut away the spur. A Pryor hysterectomy clamp, if used, should be introduced well into the 2 legs of the artificial anus, and will take from 3 to 7 days to cut through and come away (Fig. 11). A No. 8 Wyeth modified Wales bougie is then introduced through the rectum and passed beyond the artificial anus. Its tip will usually come out of the artificial anus, but it must be re-introduced and carried on into the upper leg of the spur. (Fig. 12.) Its elasticity will press the spur backward and cause the mucosa of the artificial anus to roll inward. The bougie is left in for 2 hours, 3 times a day, until the wound caused by the cutting away of the spur has healed and a wide aperture is left for the downward passage of fecal material.

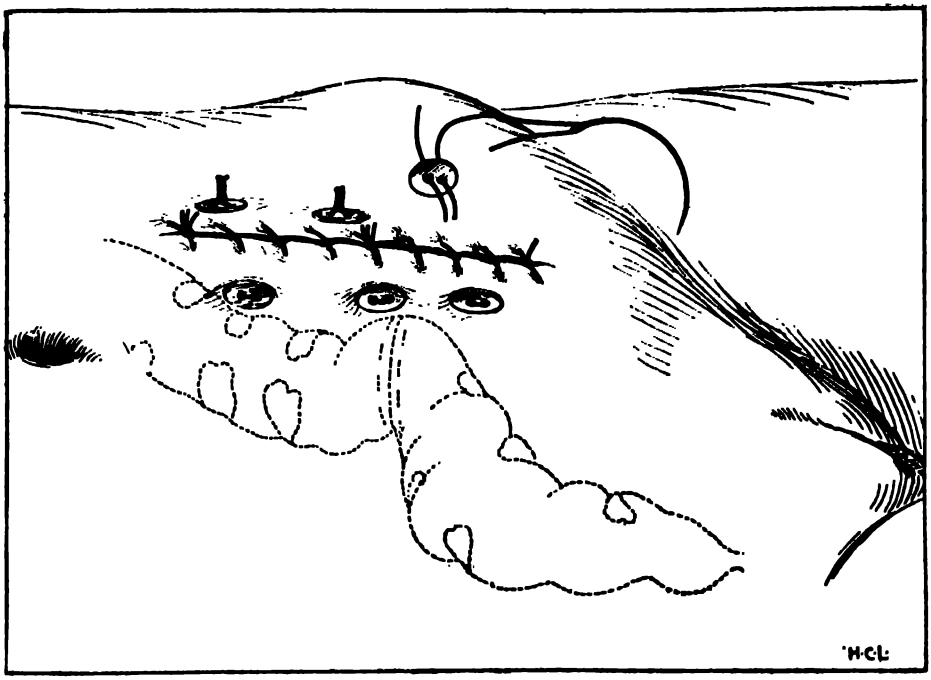

Fig. 13.--The Method of Closing the Artificial Anus after It Has Outlived Its Usefulness.

The final steps are as follows: The edges of the artificial anus are dissected away from the skin and fascia of the abdominal wall down to the peritoneum; the aperture in the gut is sewed up by one row of through-and-through sutures and one of Lembert's, which must be carefully placed, the first being of silk and the last of fine chromic gut. The peritoneum is stripped from the abdominal wall for about ½ in. all around the wound; the cicatricial tissue and the fascia are trimmed away; 3 or 4 double anchoring sutures threaded upon agate buttons are passed across the wound and out through the skin on each side about 1 in. from the margin; after these have been tightened, an ordinary subcutaneous suture brings the skin together. The buttons serve as bases for the deep sutures to rest upon and prevent their cutting into the

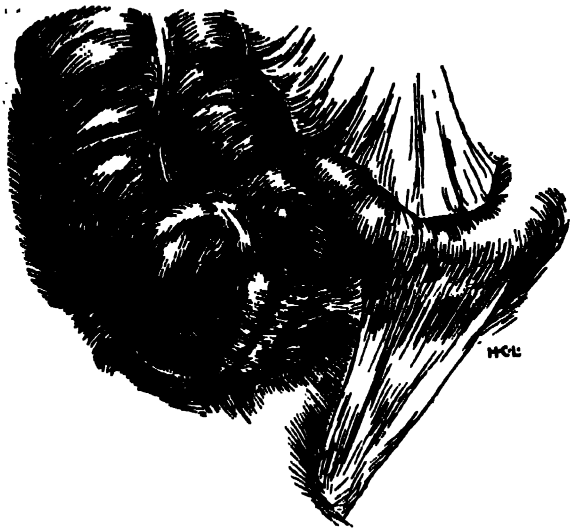

FIG. 13A.—LANE KINK. Chronic appendix, kinked and covered by membrane.

skin, rendering them much less painful than the ordinary tension sutures; and if the wound should gape, one can twist the button like a tourniquet and bring the edges closer together.

ILEOSIGMOIDOSTOMY

The patient, having been previously carefully prepared by diet and catharsis, is given 1/150 gr. hyoscin and 1/4 gr. morphin 2 hours before the operation. The abdomen is prepared by painting with tincture of iodin when the patient is on the table. The abdomen is opened by a median incision. After the fascia is reached, the skin is covered with a sterile towel held in position by clamps specially designed by Lane (Fig. 2). After the towels are in place, the incision is continued until the abdomen is open (Fig. 3). The cecum is brought into view, and by taking this as a landmark, the ileocecal portion of the bowel is located. About 6 or 8 in. from this point, the ileum is brought up into the wound and double clamped (Fig. 14). After this the portion of the bowel around the clamps is carefully walled off with gauze. A purse-string suture is placed around the aboral loop of the ileum close to the clamp (Fig. 14). One blood-vessel is tied (Fig. 14), permitting a separation of a portion of the oral limb from the mesentery, so that it can be swung around and attached to the sigmoid. The ileum is now divided between the 2 clamps by means of the cautery (Fig. 14). The forceps is taken off the aboral end, the purse-string suture drawn and tied, an assistant aiding to invaginate the end of the bowel.

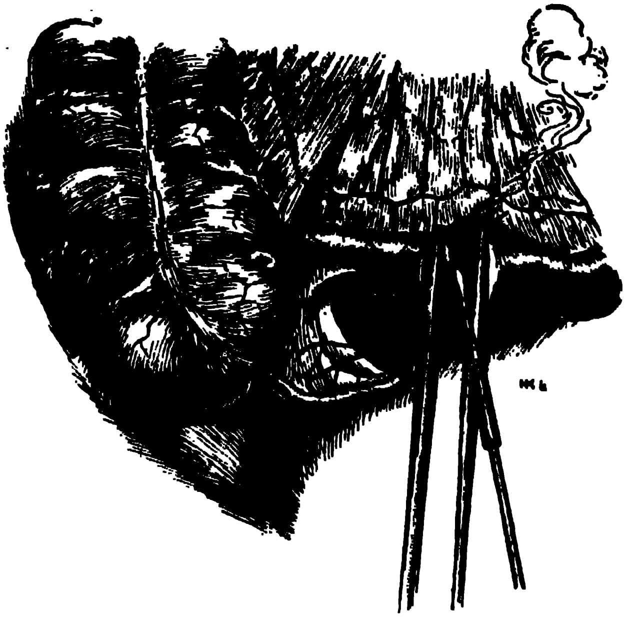

FIG. 14.—FIRST STEP IN THE SHORT-CIRCUITING OPERATION. It shows the clamps in position, the small artery tied so as to allow anastomosis of the ileum to the sigmoid later, and it also shows the method of dividing the bowel by means of the cautery.

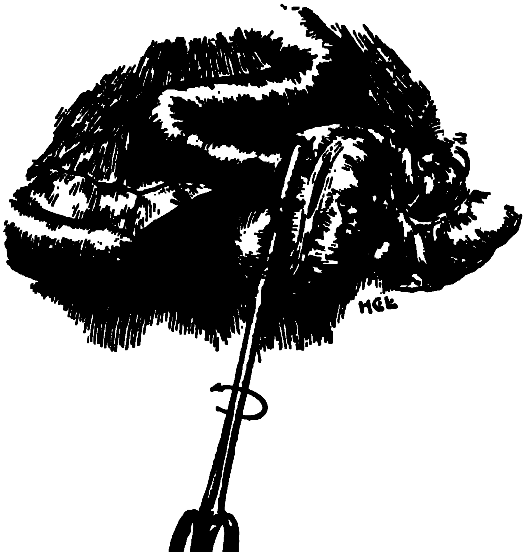

FIG. 15.—THE ILEUM SWUNG OVER AND ATTACHED TO THE SIGMOID. The slit in the longitudinal muscular band and the closing of the caudad ileum are shown. This illustrates the second step of the short-circuiting operation.

The gauze is now removed, and the oral loop, with the forceps in place, is swung around to the left and the bowel rolled upward on the forceps for half a turn (Fig. 15). The portion of the sigmoid to which the ileum is to be attached is now selected, and the ileum, as in Figure 15, sutured to the side of the sigmoid by Lembert sutures. The bowel is unrolled on the forceps and held in position by an assistant, while the surgeon makes a slit in the longitudinal muscular band of the sigmoid corresponding to the size of the opening in the ileum (Fig. 15). The ileum and sigmoid are next united by a glovers' suture (Fig. 16) and the bowel is closed by means of a modified Connell suture (Fig. 17). After this a Lembert suture is occasionally used to cover the Connell. I have not found this necessary.

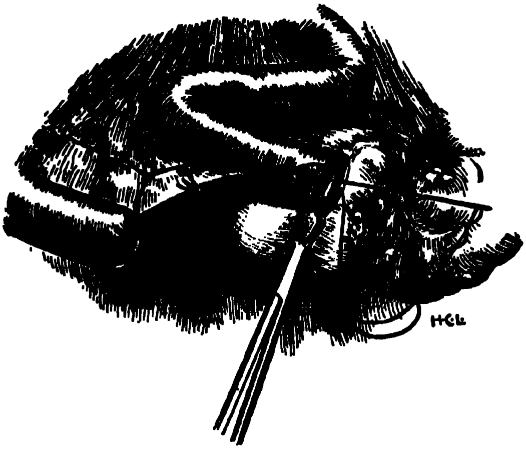

FIG. 16.—THIRD STEP OF THE SHORT-CIRCUITING OPERATION.

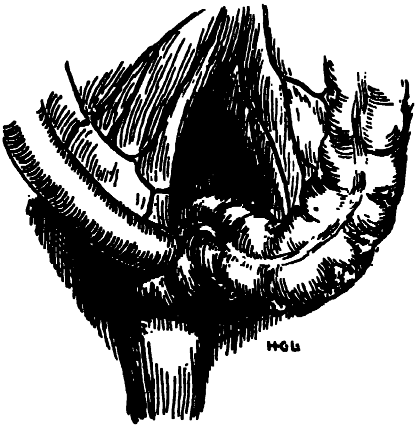

FIG. 17.—SHOWING THE ANASTOMOSIS COMPLETED AND THE OPENING IN THE ILIAC FOSSA, WHICH IS TO BE CLOSED LATER.

The next step in the operation is a very important one and consists in closing over the iliac fossa. Lane is in the habit of closing it from above. (Fig. 18).

This necessitates complete evisceration with resultant shock. For this reason I have modified this procedure and close the fossa from below instead of from above.

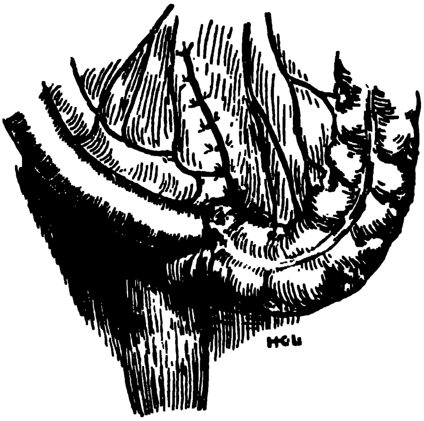

FIG. 18.—SHOWING LANE'S METHOD OF CLOSING THE ILIAC FOSSA. This necessitates evisceration.

This is easily accomplished by putting the patient in the Trendelenburg position. The method of closing is shown in Figure 19. Sir Arbuthnot Lane prefers to have a rectal tube passed up through the rectum and sigmoid by an assistant. After the tube has reached the ileosigmoidal opening it should be gently manipulated and guided through the opening by the operator's fingers and passed into the ileum for about 3 in. When

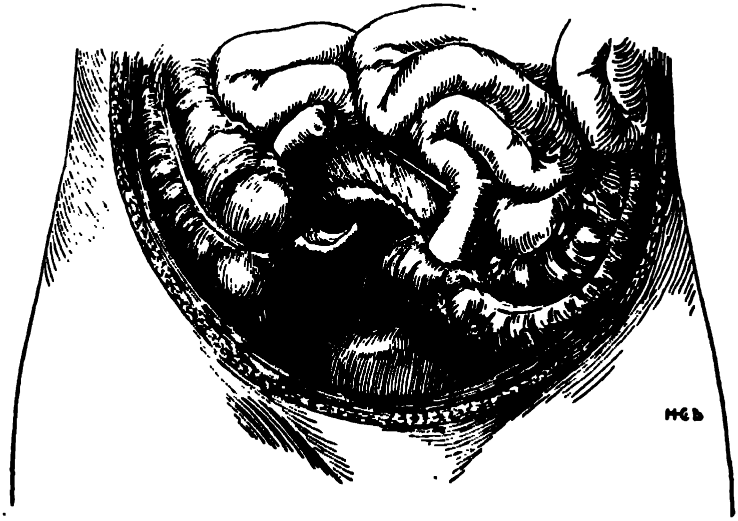

FIG. 19.—SHOWING LYNCH'S METHOD OF CLOSING THE ILIAC FOSSA. Evisceration is avoided by this method.

the tube is in position, it is held in place by a fine, plain catgut suture. I have never used this tube. Sir Arbuthnot Lane passes 4 or 5 ounces of Russian mineral oil through the tube after the operation is completed.

COLECTOMY

Indications.—This operation is indicated when there is marked stasis, with the colon so redundant that it invites removal. The only drawback to the short-circuiting operation is the fact that about 5 per cent. of the cases have anastalsis. When this condition exists, some difficulty is experienced in emptying the colon, and the patients are almost certain to have a recurrence of their original trouble. For that reason, when the colon is not fused it is better to short circuit, and at a subsequent operation do the colectomy. We think that removal of the first portion of the colon, with anastomosis between the ileum and the transverse colon, in the majority of cases, except where the adhesions around the splenic flexure are pronounced, will answer the same purpose as short circuiting and complete removal of the colon. There is a great difference in the mortality between the 2 operations.

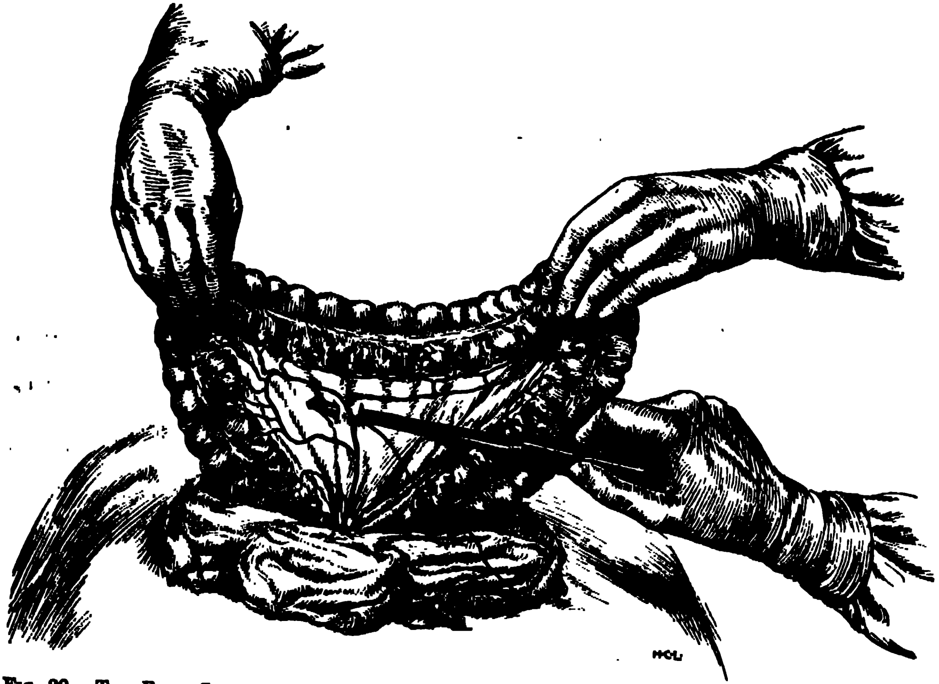

FIG. 20.—THE FIRST STEP IN THE OPERATION FOR COLECTOMY. It shows the forceps passed around the middle colic artery, and the bowel being held in place by an assistant.

Mortality.—Removal of the first part of the colon should have a very low if any mortality. Removal of the entire colon must of necessity have a rather high mortality—we should say roughly 20 per cent.

Technic.—A median incision is made about 6 in. long, 3 in. below and 3 in. above the umbilicus. This incision, if necessary, can be extended up or down. The transverse colon is held up by an assistant and the middle colic artery is first tied about 1 in. from the junction of the bowel with the mesentery, which is accomplished by passing a suture on a long forceps. After the middle colic artery has been tied, a fairly large slit can be made in the transverse mesocolon and the hand passed into the lesser cavity. With one hand in the lesser cavity, the great omentum and gastrocolic omentum can be stripped over the colon. It may require 2 or 3 sutures to prevent hemorrhage, but this part of the operation can be accomplished within a few minutes and with very little traumatism. With forceps and a long suture of iron-dyed linen, the colon is gradually tied off. By passing a suture back and forth and tying a little at a time, no raw edges are left, and the colon can be removed in a very reasonable time. After the colon has been thoroughly freed from its attachment to the mesocolon, and anastomosis has been made, the upper end of the sigmoid, about 1 in. above the anastomosis, is turned in and the excessive colon removed.

COLOSTOMY

Colostomy is the formation of an opening in the bowel, after it has been attached to the abdominal wall, having for its object primarily the side tracking of the fecal current, temporarily or permanently, because of some pathological lesion below the opening. Fortunately there are not many conditions which necessitate such radical means for their relief. Its usefulness has been curtailed considerably since the advent of appendicostomy and cecostomy. It is now very seldom indicated except in lesions below the descending colon, because in conditions above this we can accomplish the same result with a lateral anastomosis and save the patient the depressing influence of this operation. Especially is this so when we consider that, notwithstanding the ingenuity of modern surgery, no operation has been devised that offers any degree of security to the patient from fecal incontinence. In a word, continence is the exception rather than the rule. It is not to be wondered at, then, that so many patients prefer to take the risk of the radical operation than to submit for the rest of their lives to a colostomy. However, "beggars cannot be choosers," and to unfortunates beyond the reach of the knife this operation, notwithstanding all its drawbacks, affords relief from pain and other symptoms which are part and parcel of this disease. Before the days of antiseptic surgery, when few had the temerity to enter the abdomen, lumbarcolostomy was very popular, but it has outlived its usefulness and is now seldom spoken of except to be mentioned in connection with operations that have been relegated to the past.

Temporary Colostomy.—As far as the general principles are concerned, the procedure of temporary colostomy is the same, no matter where it is done, but the details vary to a slight degree depending upon the location. The opening should be accessible, easily made and readily closed, and placed at the most convenient point above the lesion, without unnecessary sacrifice of time or tissue. The patient having been previously prepared as for any laparotomy and the site of the opening settled, a vertical incision is made on the outer side of the rectus muscle through the skin and subcutaneous fat, and later through the fascia; the rectus muscle is next retracted to the inner side, when the transversalis fascia and peritoneum come into view; all bleeding points are then caught by means of artery forceps and the peritoneum is lifted up between 2 pairs of thumb forceps, the assistant holding one and the operator the other. Between the 2 forceps a slit is made in the peritoneum and it is then clamped on either side by artery forceps; by gradually elongating the opening, as the peritoneum is lifted up, injury to the intestines will be avoided. The operator will now pass his gloved hand into the abdominal cavity and locate the portion of the large intestine which he wishes to fix. This is brought outside the abdominal cavity and caught by an assistant and the gut pulled down in order to prevent subsequent prolapse. A bloodless spot in the mesentery is selected and through this space a pair of forceps is passed; the forceps are opened and a glass rod inserted; the rod drawn back through the opening acts as a support for the bowel. Under either end of the glass rod a piece of gauze is placed to prevent it from injuring the skin. The peritoneum is sewn around the bowel by means of 4 to 6 interrupted plain catgut sutures, and the wound is then closed by silkworm-gut sutures, which are passed through the skin, fascia and back again through the fascia and skin. In this way the wound is closed snugly around the bowel. Finally, a piece of rubber tissue is wrapped around the bowel to prevent anything adhering to it, and over this is placed some gauze, which is held in position by adhesive straps. Of course the straps should not be placed over the bowel. (Figs. 21 and 22.)

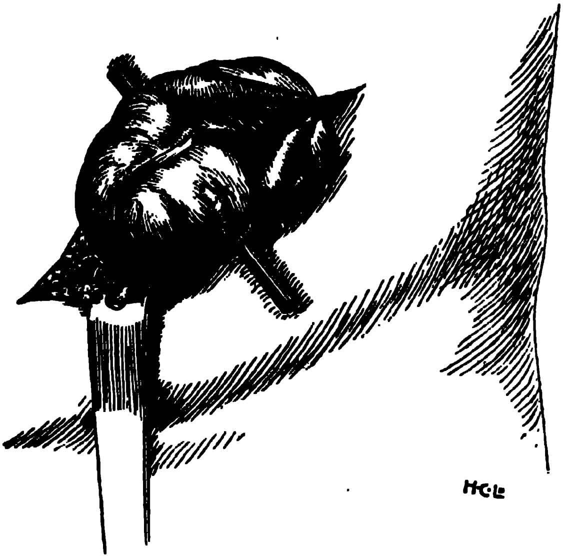

Fig. 21.—Lynch's Method of Opening the Bowel after Colostomy. It also shows the aboral end after the opening has been made. Notice how both sides of the bowel roll back like a withered leaf.

While I do not agree with those surgeons who advocate colostomy preliminary to a more radical operation, I can see the utility of it in certain cases. It affords the surgeon an opportunity to make an examination of the abdominal contents and of the extent of the pathological lesion, so that if a future operation is contemplated he gets a good idea of what can be accomplished with safety. This opportunity is particularly valuable in case a malignant growth exists, because it can be determined accurately whether neighboring organs, such as the bladder and the uterus, are involved and, above all, the extent of glandular and liver involvement can be noted. The surgeon can further determine whether the sigmoid is sufficiently long and healthy so that the continuity of the bowel may be restored later. Last, but not least, it can be settled whether the opening shall be made in the sigmoid or transverse colon.

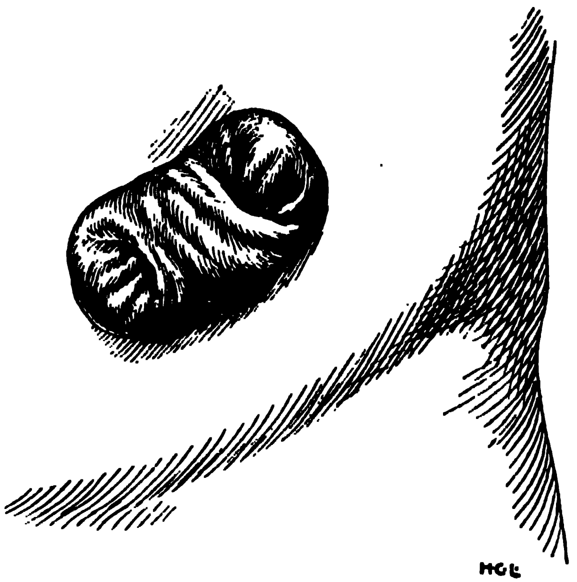

Fig. 22.—The Artificial Anus One or Two Weeks Subsequently.

Permanent Colostomy.—This operation is resorted to only in those cases where all other procedures are contra-indicated. Its object is the sidetracking of the fecal current to save the patient from intestinal obstruction, so that, as in malignant conditions, the patient's life may be prolonged and his remaining days made fairly comfortable. It is also performed in those cases of benign tubular stricture where it is impossible to do anything in the way of a radical operation and restore the continuity of the bowel to the anus, and in other conditions, when, owing to the age of the patient, it would be folly to try anything but the simplest operation. Then again the condition of the patient may be such, either because of some wasting disease or involvement of heart or kidneys, that there is no hope of doing more than prolong his life temporarily or relieve him for the moment of distressing symptoms.

Several operations have been devised with the object of improving the patient's control over the movements of the bowels; but the results, so far as I can judge, have not been all that the patient craved or the surgeons who devised them hoped. For this reason I have selected for description only those operations which, in my opinion, have given the best results.

TUTTLE OPERATION.—An incision is made through the skin and superficial fascia in a line with the fibers of the external oblique muscles, about 1 in. above and 1½ in. inside of the anterosuperior spine of the ileum. It should be about 3 in. long. The fibers of the external and internal oblique are separated by blunt dissection. Blunt retractors are placed in the wound and held in position by an assistant; then the transversalis fascia and peritoneum are picked up and incised in a line parallel with Poupart's ligament.

After abdominal exploration has been carried out with the hand and a permanent inguinal colostomy has been finally determined upon, a loop of sigmoid sufficiently long to be drawn at least 2 in. outside of the abdominal cavity is selected, and a tape or loop of large silk is passed around it through a small slit in the mesentery, the ends being left long and held by an artery forceps. The lower fibers of the external oblique are then pulled downward, and the internal oblique split laterally to the distance of about 2 cm. (3/4 in.) A canal is then made between the skin and the external oblique downward to the extent of about 2 in., opening through an incision in the skin just above Poupart's ligament. This canal and incision should be large enough to admit of the loop of sigmoid being drawn through them without much compression. With the aid of the dressing forceps, the knuckle of gut is then dragged through the lateral slit in the internal oblique and downward through the canal outside of the external oblique muscle until it emerges at the inferior opening in the skin. It is held in this position by the passage of a glass rod through the opening in the mesentery, or by suturing it to the edges of the skin wound. The abdominal wound is then closed by chromicized catgut sutures in the muscular layers and a subcutaneous silk suture in the skin; it is then sealed by iodoformized collodion and dressed with sterilized gauze, over which a layer of rubber protective tissue is placed and sealed to the skin with chloroform. The latter precaution is taken to avoid infection of the primary wound through the escape of feces when the gut is opened.

If necessary, the loop of the intestine may be opened immediately, but ordinarily it is better to wait 24 to 48 hours before doing so. This is accomplished by a simple slit in the line of longitudinal fibers of the gut. After 10 days or more, the protruding portions of the gut should be trimmed down flush with the skin and the artificial anus will present itself as a double-barreled aperture, one opening of which connects with the proximal and the other with the distal end of the sigmoid. The gut is brought outside of the external oblique muscle in order that it may rest upon a resisting plane, and a truss or compress can be placed upon it, thus absolutely occluding its caliber. Being passed through the slit in the internal oblique, it is surrounded by muscular fibers, and thus obtains a certain amount of voluntary control. In the majority of cases, no compressing apparatus is necessary, as the patient usually possesses almost complete continence without it. When it is necessary, an ordinary single-spring hernial truss, with an elongated pad placed somewhat outside of the usual position, serves every purpose.

AUTHOR'S METHOD.—My own method is much the same as Tuttle's, with some modifications. Instead of bringing the gut through a slit in the internal oblique and then under the skin, the gut is brought out through the wound and held in place by an assistant. A bundle of muscles is separated from the lower lip of the external oblique and the gut is pulled through this opening by forceps. From the upper lip another bundle is selected and the gut pulled through the upper opening. In this way a regular figure-of-8 sphincter is formed. The wound is closed by 1 or 2 silkworm-gut sutures on either side, which include the skin and superficial fascia, and the operation is complete. The intestine is opened immediately, if necessary, and a "Paul tube" inserted and held in place by a purse-string suture. At the end of 10 days the intestine is cut flush with the skin and the edges sewn with a continuous plain catgut suture.

Indications for Colostomy.—1. Inoperable carcinoma of the rectum or sigmoid.

2. Stricture of the rectum or sigmoid.

3. Multiple polyposis with severe hemorrhage.

INOPERABLE CARCINOMA.—There is no questioning the fact, which is borne out by clinical experience, that inoperable cases of malignant disease of the rectum are made comfortable by colostomy. Those patients very often gain in weight and live for several years in comparative comfort. I am of the opinion that, when the tumor is situated in the sigmoid and is inoperable because of glandular or liver involvement because of the patient's condition, it would be much wiser to implant the ileum in the rectum, following the method advocated by Kelly, or to perform lateral anastomosis, rather than leave the patient with a colostomy. We have done this operation on several occasions and have been well pleased with the results. One case in particular is of special interest.

An old lady, referred by Doctors William Donovan and Harlow Brooks, was threatened with intestinal obstruction because of a tumor situated in the cecum and ascending colon. The woman's condition was not such as to encourage a very extensive operation, but she had to have some relief and that immediately. I opened the abdomen and made a lateral anastomosis between the ileum and the transverse colon. The woman was out of the hospital 2 weeks after the operation and has been attending to her house duties ever since. She is exceedingly comfortable, and I am satisfied that I have given her more comfort than I could possibly have done had I left her with the colostomy or tried the radical operation.

STRICTURE OF THE RECTUM OR SIGMOID.—Colostomy is indicated in stricture of the rectum first, when the patient's life is threatened with intestinal obstruction and an immediate relief is demanded; second, where the tube is still patent but, owing to the diminished caliber, the bowels are not thoroughly emptied and an added toxemia demands short circuiting of the current in order to get the patient into better condition before proceeding with more radical measures; third, where there is an accumulation of pus owing to ulceration. Under the last circumstances it seems wiser to make an artificial anus, because if a radical operation is attempted, infection almost inevitably results in the formation of connective tissue and negatives the purpose for which the operation was performed.

It is also wise to perform colostomy in cases of annular stricture, because otherwise it is impossible to tell how far the process extends and a radical operation may result disastrously. This was forcibly brought before us in a case of Professor Tuttle's which he has reported.

The points to be observed in doing a colostomy are:

1. Always pull the upper end of the bowel down until it is taut, as by so doing a subsequent prolapse is avoided. If a prolapse occurs, it is certain to make the patient's life miserable, and may end his life altogether. Incidentally, should he survive, his condition stands as a monument to the error of the surgeon.

2. It has been shown by Lennander, and is borne out by my experience, that when the mesentery is pulled pain results. It is, therefore, easy to remember that an intestine with a short mesentery is not suitable for a colostomy. It will cause the patient untold suffering and most certainly result in failure, the colon later on retracting and the colostomy closing. Therefore, if the sigmoid is found unsuitable, the transverse colon should be selected.

3. Because of failure to find a suitable space, the fecal matter finds its way into the distal opening, causing the patient great inconvenience and very often obviating the purpose for which the colostomy was performed. Difficulties almost insurmountable, in some cases, are experienced in doing this operation We have met some cases where, owing to inflammation and adhesions, it was next to impossible to get hold of a portion of the colon sufficiently long to form an artificial anus. This condition has been met with on more than one occasion in malignant conditions and also in stricture. I had a case, recently, where the sigmoid was so twisted and bound down by adhesions and the bowel was so friable that it was with the greatest difficulty the colostomy was performed.

In very fat subjects many obstacles are encountered. In the first place, it is with much difficulty that the small bowel can be kept in the abdomen, and by those not experienced the transverse colon may be mistaken for the sigmoid, when it is prolapsed. In these subjects, if great care is not exercised, a hernia will result. Suppuration of the wound with fistulous tracts also occasionally results, if the operator's technic is not perfect.

MULTIPLE POLYPOSIS.—Sometimes, owing to severe hemorrhage in multiple polyposis of the rectum and sigmoid, the patient's life is in danger. A colostomy, under such circumstances, will very often save the patient. I had such a case under observation this year; but unfortunately she was in such a reduced condition when seen that it was hardly possible to hope for a favorable result. The colostomy was done under gas in about 10 minutes, and, though the patient died 3 weeks afterward as a result of inanition, the colostomy made her very comfortable during the few days of life she had left. I am convinced that had I seen her earlier her life might have been saved.

When Should the Bowel Be Opened?—When the bowel should be opened depends in a great measure upon the exigencies of the case. If intestinal obstruction is threatened, it must be opened immediately, and in my opinion the tube of Paul permits a safe opening without much danger of infection. If there is no immediate haste, we may make the opening on the fifth day after operation. As a matter of fact, there is little danger attached to the opening of the bowel after 48 hours. If some rubber dam is carefully wrapped around the bowel, an infection of the wound is not likely to result. If an accumulation of gas causes the patient any great inconvenience, it may be relieved by puncturing the bowel with a fine trocar and cannula, which can be held in place by a suture until such time as the surgeon is ready to make the final opening. The opening of the bowel, following this operation, is very important, because if it is properly performed it is easier to close it later on. I think the procedure advocated by Tuttle is about the best; it has given the most satisfaction in my hands. The gut is opened in the following manner: First, by a transverse incision which bisects the gut. From the middle of this incision a vertical incision is made which extends to the apex of the upper bisected portion of the gut.

"By this means the triangular flaps in the upper segment roll backward and curl up like dry leaves. The straight flap in the lower segment falls downward and inward, practically closing the lower aperture. The fecal discharges are thus carried outside the abdominal cavity and there is scarcely any possibility of their escaping into the lower segment. In addition to this, no portion of the intestinal wall is sacrificed; and when it becomes advisable the artificial anus can be closed by simply suturing the edges of the T-shaped wound together without opening the peritoneal cavity. At the same time the lower segment may be opened by simply lifting up the transverse flap, thus furnishing an opportunity for irrigation and treatment of the parts below so long as it is necessary" (Tuttle).

When Should the Opening Be Closed?—This depends entirely on the conditions that demand this procedure, and must be left entirely to the judgment of the surgeon in charge. After it has served its purpose, it may be closed at the convenience of the patient, and when in the judgment of the surgeon there is no contra-indication to so doing. He should not be influenced by the impatience of the patient and try to close the opening, however, unless absolutely certain all symptoms for the relief of which this operation has been performed have disappeared, and in his judgment it can be done with absolute safety, and with no risk of a recurrence of the pathological lesion.

CECOSIGMOIDOSTOMY

Cecosigmoidostomy can only be performed when the cecum is movable and the sigmoid is unusually long. There are 2 methods of performing this operation. The first method was suggested by one of my associates, Dr. Yoemans. The second was described by Lardennois and Okinczye (15) and is as follows:

Method of Lardennois and Okinczye.—"The patient is placed in the Trendelenburg position and a long median incision is made from the pubes to the umbilicus. The colon is rapidly explored for the clinical lesions and the termination of the small intestine inspected for the only possible contra-indications to this operation, namely a stenosing band across the ileum.

"FIRST STEP: The cecum and sigmoid flexure are brought well up into the wound. This is easily accomplished, as lesions for which the operation is indicated are usually accompanied by a 'cecum mobile.'

"SECOND STEP: This consists in the approximation of the mesenteries and the closure of the buttonhole formed by the mesentery, the posterior parietal peritoneum and the pelvic mesocolon. This is done as follows (Lane's technic): Beginning with the right surface of the mesocolon, a suture is run from the sigmoid to the posterior parietal peritoneum and the sacral promontory and thence to the left surface of the mesentery close to its termination. Great care is exercised to avoid blood-vessels. The 2 ends of the suture are held in a clamp and are not tied until the anastomosis is completed.

"THIRD STEP: Appendectomy is performed quickly, as the appendix interferes with the anastomosis.

"FOURTH STEP: An intestinal clamp is placed above the bottom of the cecum to mark the limit of the cecum which is to be resected.

"FIFTH STEP: After milking away the contents, two intestinal clamps are placed on the sigmoid. It should be cut high enough toward the colon to make the right cecosigmoid branch a little longer than the left colon sigmoid branch in order to leave some distance between the two anastomoses. If the colon loop is too long, the Y will be inverted, which might lead to a vicious circle. The 2 clamps should include most of the depth of the mesocolon and the extremities should be in apposition.

"SIXTH STEP: The iliac sigmoid is now cut between the clamps, the cut surfaces being cauterized. The mesocolon is cut to the end of the long clamp and immediately sewed over to control hemorrhage. The upper extremity of the cut colon is wrapped in saline gauze and laid aside.

"SEVENTH STEP: The inferior end of the sigmoid is placed in apposition to the cecum and the posterior layer of seroserous sutures is passed.

"EIGHTH STEP: The anastomosis between the cecum and sigmoid is completed, both sigmoid and cecum being cut across just proximal to the sealing clamps before the sutures are passed.

"NINTH STEP: The compresses are removed from the superior end of the cut sigmoid and, after choosing a point far enough from the cecal anastomosis and at the same time high enough so that the work can be done outside the abdomen, the sigmosigmoidostomy is done in the usual manner. This presents no particular difficulty as patients for whom this operation is indicated usually have a long sigmoid.

"TENTH STEP: The suture as passed in step two is now tied just tight enough to close the opening in the mesentery, and the operation is terminated by replacing the intestines and closing the abdomen.

Yoemans' Method.—The technic of the method suggested by Yoemans (26), as used by me in the 5 cases in which this operation has been tried, is as follows: The portion of the cecum which most readily adapts itself to the sigmoid is selected. A clamp is placed on this portion of the sigmoid and another clamp on the cecum, preferably near the longitudinal muscular band. If the appendix interferes with the anastomosis, it is removed, and under such circumstances, with a movable cecum, it is often possible to make the anastomosis along the line of attachment of the mesoappendix to the cecum. Both ends of the bowel having been clamped, 2 clamps are brought accurately in apposition and held in place by an assistant.

Either a straight or a curved intestinal needle is threaded with the finest iron-dyed linen, and the suture applied in the following manner: The operator inserts the first stitch in the bowel at the distal end of the clamp. With this suture the serous and muscular layer of the bowel are picked up and the stitch is continued until the bowel at the proximal end of the clamp is reached. After this stitch is completed the needle is temporarily laid aside.

An incision is now made ⅛ in. from either side of the suture line. The serous and muscular layers being divided, the mucous membrane comes into view. After the length of the opening has been decided on, the mucous membrane is opened. As a general rule, owing to the retraction of the outer layers, the mucous membrane appears to be redundant, and it is sometimes necessary to remove a portion of it before continuing the anastomosis. The next suture embraces all the layers of the bowel, and should preferably be a button-hole stitch. Great care should be exercised to see that the mucosa is in perfect apposition. This is very important, as it prevents subsequent hemorrhage and ulceration, which very often occurs if the mucosa is not in perfect apposition. For the outside stitch we prefer a modified Connell. The needle is first passed through the mucosa and brought out through the serosa, from there it goes across to the opposite side, through the serosa, back into the mucosa, and is tied on the inside. After the first end is tied, the needle is passed through the mucosa, out through the serosa, across to the opposite side, through the serosa, through the mucosa, back again on the same side, through the mucosa, back through the serosa, then across over to the other side through the serosa, back through the mucosa, out again on the same side, etc. After this suture, the clamps are removed and the parts carefully wiped off with saline solution. All towels and pads which have been in immediate contact with the wound during the previous part of the procedure are removed, and sterile pads substituted. At this point it is well for the operator to change his gloves, as soiling of them during the first part of the operation is almost inevitable. A Lembert suture completes the operation. This suture should embrace only the peritoneum, and covers over the last stitch. All pads and towels are now removed, the bowel returned into the abdomen, and the abdomen closed by layers. In all intestinal operations we are in the habit of using tension sutures, inserted after the manner of Dr. George D. Stewart.

ILEOSTOMY

An ileostomy is an opening in the ileum, close to the ileocecal valve, and has as its object the dividing of the fecal current, because of some lesion in the colon or rectum.

Indications.—Ileostomy is indicated in the following conditions: Acute and chronic hemorrhagic colitis, diverticulitis, and ulceration of the colon—in fact, any acute or chronic infection of the colon, where it is necessary to sidetrack the fecal matter in order to put the colon at rest; in severe toxic conditions, due to obstructions at or near the peritoneum, where it would be impossible to open the ileum below the lesion. It is particularly valuable in severe toxic conditions associated with diverticulitis. We have demonstrated more than once the value of this operation in such severe toxemias. In one case in particular, a lady had been incapacitated for several years, and for 1 year had suffered from hallucinations and illusions. We are sure that Dr. Robert Morris, Dr. Elliot, and Dr. Brewer, with whom we were associated in this case, will vouch for the almost unbelievable improvement that followed ileostomy.

Prior to our advocacy of this operation, the impression prevailed that the exclusion of the colon meant loss of weight. We have now demonstrated, and shortly published a paper on this subject, showing that this impression is erroneous, and that, contrary to our former ideas, the patients all gain in weight after the exclusion of the colon.

The following is a list of conditions in which the operation is indicated:

Multiple polyposis.
Tuberculosis.
Membranous enteritis of the end of the colon, ankylostomiasis.
Chronic ulcerous colitis.
Acute croupous inflammation, streptococci of the colon.
Croupous enterocolitis.
Acute necrosing ameba-dysentery of the ascending and transverse colon.
Gangrenous, ulcerated, acute ameba-dysentery of the colon.
Ulcerous, subacute gangrenous ameba-dysentery of the colon, partly confluent.
Recurrent nodular ameba-dysentery of the colon, with partly superficial nodular condition.
Chronic colitis.
Acute Shiga-dysentery of the whole colon.
Chronic, ulcerous, torpid dysentery bacilli.
Ankylostomiasis.
Quicksilver enteritis of the descending colon.
Membranous colitis.
Terminal diphtheritic colitis.
Septic, croupous enterocolitis.
Embolic, septic, necrosing colitis.
Multiple polyposis.

Instruments Used in Ileostomy.—The following instruments are required: 2 knives; 2 pairs of scissors; 4 thumb forceps, 2 plain, and 2 mouse-toothed; 1 dozen artery forceps; 2 curved intestinal needles; 2 round needles for the peritoneum; 2 spear-pointed needles; a glass rod.

Technic of Operation.—BATTLE INCISION.—The peritoneum having been opened, the ileum is ligated as it enters the cecum. It is advisable to make the ileostomy close to the cecum, so that if irrigation of the large bowel should be necessary, a catheter can be passed through the ileocecal valve without difficulty. The ileum is held up by an assistant, and a bloodless space selected in the mesentery. Having located this space, an incision is made through it, and a glass rod run through the opening. The peritoneum is closed by a few interrupted sutures on the other side, so as to secure the peritoneum to the bowel. The fascia is closed with interrupted sutures, and the skin closed in the usual manner. A swab is placed underneath to prevent excoriation of the skin. Unless it is urgently demanded, the bowels should not be opened for from 3 to 5 days after the operation. By this time the wound is fairly well sealed off, and there is very little danger of infection. If, for any reason, the bowel has to be opened, this can be accomplished with little risk, if a catheter or a Paul's tube is used. The fixing of a Paul's tube in the bowel is as follows: A longitudinal slit is made in the anterior wall of the bowel, and a purse-string suture is made around this opening. One end of the Paul's tube is inserted in the opening, and the purse-string suture tied, thus preventing leakage. At the end of the 5 days, the Paul's tube comes away, and the opening in the bowel can be extended. If it is considered desirable to bring the cecum into view, the following procedure may be adopted: Sewing the ileum to the cecum, bringing out the ileum and cecum, after the manner of Tuttle or Paul, and when it is necessary to close the bowel, cutting the septum between the ileum and cecum and closing the wound after the manner of Tuttle.

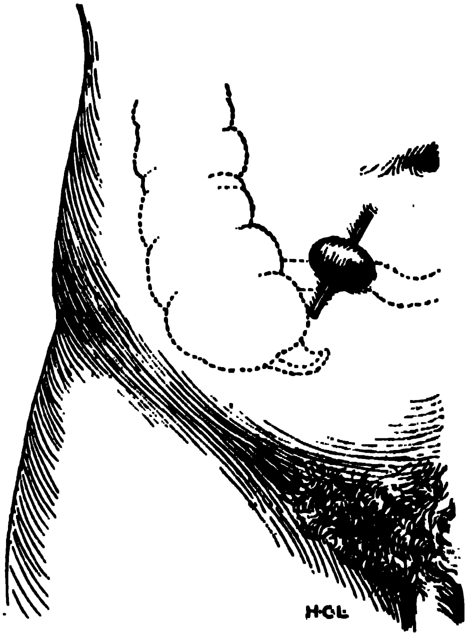

FIG. 23.—SHOWING THE POSITION WHERE THE ILEUM SHOULD BE BROUGHT OUT WHEN FORMING AN ILEOSTOMY.

After-treatment.—The after-treatment is exceedingly important, because if it is not understood the patient may suffer severe maceration of the skin and infection may develop. The skin around the ileac opening should be carefully washed with 95 per cent. alcohol, and when dry, it should be covered with a thin coating of ointment of zinc oxid, and later on dusted with starch. A little roll of cotton around the opening is sometimes a great protection against fecal soiling.

CECOSTOMY

The operation was suggested by Dr. C. L. Gibson, of New York, as a means of irrigating the colon. It is an adaptation to the colon of the principles of Senn's gastrostomy. The technic of the operation is as follows: The patient is prepared as for any laparotomy, that is, he is given a bath the night before the operation and sterile dressings are put on the abdomen, followed by painting the abdomen with a 5 per cent. solution of tincture of iodin just before the operation. A Kammerer incision is made. After the fascia has been reached, the skin is covered with sterile towels, which are made fast to the edge of the wound with Lane's towel clamps. This having been done, the operator proceeds to incise the fascia down to the muscle and to pull the muscle to one side by means of a retractor. The operator reaches into the iliac fossa and with a gloved hand seizes the cecum and brings it up into the wound. The site to be selected for the cecostomy is now determined. This is usually opposite the ileocecal valve. An incision is made sufficiently large to admit a catheter. The catheter is passed in until it reaches the posterior wall of the cecum, and is then gradu-

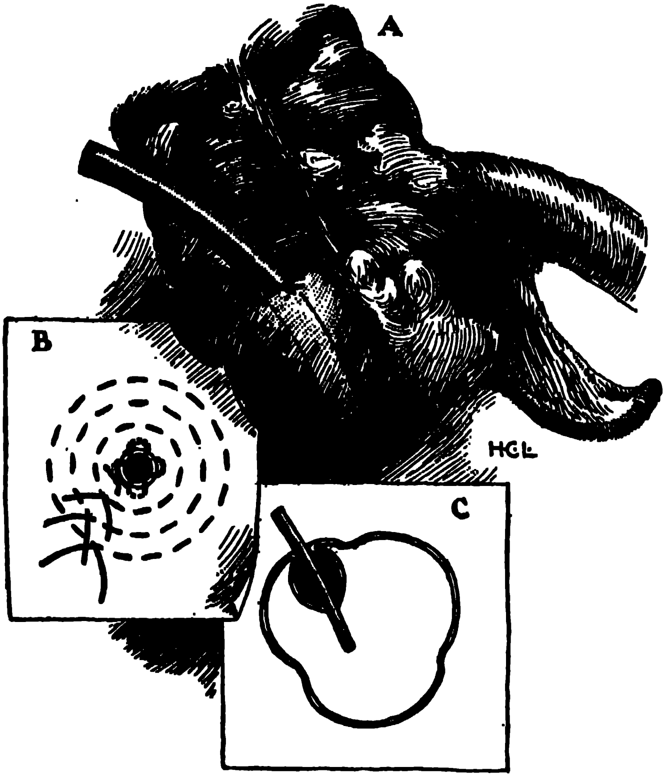

FIG. 24.—THE VARIOUS STEPS IN THE OPERATION OF CECOSTOMY.

ally withdrawn until it hangs free in the bowel. It is then fixed by means of a plain catgut suture, which passes through all the coats of the bowel and through the catheter. The peritoneum is next infolded by means of a series of circular sutures at a radius of about ½ in. from the catheter. Figure 24, B illustrates the placing of the sutures.

After all the sutures are in place and tied, the result is a cone projecting into the bowel, which prevents leakage (Fig. 24, C). It should be remembered, when tying the sutures, not to strangulate or shut off the tube. The next procedure is to fix the bowel to the abdominal wall. This is done by means of 2 sutures, which pass through the peritoneum, then through the bowel, and eventually through the peritoneum on the other side. These sutures should be taken about ½ in. from the catheter, so that if any leakage occurs around the catheter, it is practically outside of the peritoneal cavity. The wound is closed in the usual manner—the peritoneum by continuous, number 2, plain catgut sutures, the fascia by interrupted chromic catgut sutures, and the skin by means of plain catgut sutures.

APPENDICOSTOMY

Indications.—This operation is indicated in the case of obstruction of the large intestine, amebic dysentery, to prevent distention following operation, and in some cases of colitis.

Technic.—The patient having been prepared in the usual manner, the abdomen is opened by means of a Kammerer incision. The wound is protected, as previously indicated, by means of towels fastened to the lips of the wound by Lane towel clamps. This is a precaution that should never be neglected. When the abdomen is opened, the cecum can be found, and by following the anterior bend the appendix is reached and brought into the wound. The appendiceal artery should be ligated close to the first branch that is given off to the appendix. This precaution is exceedingly important, as this branch furnishes a good supply to the base of the appendix. The mesentery of the appendix is stripped off, and any bleeding points are clamped and ligated. The cecum, about 1/10 in. from the appendix, is sutured to the peritoneum. The fascia is closed by means of interrupted sutures. The greatest care should be taken not to strangulate the appendix when closing the fascia. The skin is fastened on either side of the appendix by means of 2 plain, continuous, number 2 catgut sutures. Finally the wound is sealed by means of cotton and collodion, care being taken that the collodion does not flow around the appendix and strangulate it. The appendix is now wrapped in a piece of rubber tissue, and gauze dressings placed over all, held in place by means of adhesive plaster, thus completing the operation.

Dangers and Difficulties.—There should be very little danger, and the operation is beset with few difficulties. The usual causes of failure are lack of appreciation as to whether the appendix is patulous or not.

Complications.—Hernia occurred in a few cases, but this was easily corrected when the appendix was closed. Pain over the left hypochondriac and in the splenic region is a usual complication. Sometimes difficulty is experienced in introducing the catheter, owing to spasmodic closure of the sphincter. This can best be overcome by gentleness, patience and care, and the injection of a little olive oil previous to introducing the catheter. It is both unnecessary and dangerous to use force. After the appendix has remained open for a year, some difficulty may be experienced in closing the opening. Cureting the fistula with an ordinary ear curet and injecting ichthyol or iodoform usually brings about closure of the opening. The mucous membrane of the opening has prolapsed in a few cases. Dr. Willy Meyer (18) reported a prolapse of the cecum in an appendicostomy opening.

CONDITIONS DEMANDING SURGICAL TREATMENT

DIVERTICULITIS

Diverticula may occur in any portion of the intestinal tract, and there is an embryological excuse for their existence, in that the bowel itself is developed as diverticulum, and from the bowel are developed the liver and pancreas. While all diverticula may occur at any portion of the gastro-intestinal tract, they have a particular affinity for the sigmoid and cecum. The anatomical arrangement of the large bowel, with its longitudinal and circular fibers shortening and throwing it into pouches, favors the formation of diverticula. The appendix and cecum are themselves diverticula. Instances have been reported of diverticula of the appendix, cecum, colon, and sigmoid. Occasionally a diverticulum becomes inverted, and results in intussusception. Such an instance we shall relate later. The cause of this inversion is supposed to be a disturbance of the equilibrium between the intra- and extra-intestinal pressure. The integrity of the intestinal muscular fibers normally maintains this equilibrium. Given a weak spot in the musculature and it follows that when the intestinal contents are propelled along from one segment to another, there must be a relative vacuum in the emptied segment. Should a weak spot exist, the extra-intestinal pressure forces the diverticulum into the intestinal lumen.

Diverticula of the Cecum.—There is no reason why diverticula should not occur as often in the cecum as in the sigmoid, but the fact remains that they occur in the latter situation more often than in the former. I have seen 2 examples in the cecum. The first case was one in which the patient complained of constant pain in the region of the appendix with tenderness over the cecum on palpation. She was operated on for chronic inflammation of the appendix, and the presence of the diverticula was discovered at operation. The appendix was removed and histological examination showed that a catarrhal inflammation existed. I did not feel justified in resecting the cecum, because, even though the diverticula were present, none of them was inflamed. The patient was improved by operation but continued to have a dull ache in the region of the cecum.

The next case was interesting, and as far as we know there is no similar case in the literature.

G. Y., 12 years old, enjoyed good health until May, 1913. On that date, while returning from school, he was taken with severe pain in the right iliac fossa. He was seen by a physician. At that time his temperature and pulse were normal. During the following week he had more or less pain and vomited occasionally. The bowels were constipated and his temperature ranged between 100 and 101. At no time during the week did he have a free evacuation. On the sixth day after he was taken ill, he passed some fecal matter and mucus which was blood-streaked. He was admitted to the hospital on the seventh day of his illness. For the first 24 hours of his admittance he had severe pain and a marked rigidity of the right rectus. His temperature was 100, his pulse 60.

He was seen by me two days after his admission to the hospital, and a diagnosis of intestinal obstruction was made. About an hour after this he was put on the operating table. The abdomen was opened through a Kammerer incision, and a quantity of dark fluid oozed through the wound. The small intestines were enormously dilated and cyanotic. A large tumor, which at the time of operation was believed to be malignant, occupied the right iliac fossa. There was intussusception of the ileum, cecum, and appendix into the ascending colon. The tumor could be felt in the middle of the mass. An attempt was made to reduce the intussusception, but as the boy's condition was found very critical a rapid resection of the ascending colon was decided on. Owing to the condition of the child, no anastomosis was made, the ileum was brought out into the wound and the wound closed as rapidly as possible. The child died soon after the operation. After the mass was removed, it was found impossible to reduce the intussusception, and in order to do this, the ascending colon had to be opened. The histological examination from a piece of the tumor showed it to be composed principally of fibrous tissue with very little musculature fibers.

Diverticula of the Sigmoid.—This is the most common situation in which diverticula are found. They occur usually on either side of the gut and close to its mesenteric attachment. They vary in size but are seldom larger than a hazel nut. They are usually flask shape, the opening into the gut being the narrowest part of the diverticulum. The secondary pathology of these diverticula is brought about by the following agencies, according to Maxwell-Telling: First, the thinning of the diverticulum wall, second, the ulceration of the mucosa, third, the perforating action of the retained concretion, fourth, the presence of micro-organisms, fifth, the inflammatory reaction of varying type and degree. As a result, we may have infection of the general peritoneal cavity without rupture of the sac, gangrene of the sac with escape of the pus into the peritoneal cavity, the formation of adhesions between the bowel and some other viscera, chronic inflammation of the mesentery, metastatic suppuration, and, finally, cancer as the result of long continued irritation. We have seen 5 cases of diverticula and diverticulitis of the sigmoid.

In one case there was an opening between the bladder and the sigmoid; in another a tumor formation with an abscess in the left iliac fossa. The third case was that of an old woman with intestinal obstruction. A diverticulum became adherent to a loop of small intestine, resulting in complete occlusion with intestinal obstruction. The fourth case was an old woman with a complete intussusception of the rectum, vagina, and uterus. This case has already been reported. The fifth case was discovered accidentally when operating for another condition.

Treatment.—The treatment is surgical, but it is impossible to lay down any inexorable rule for every case of diverticulitis. The surgeon must be guided by the conditions found at operation. If acute inflammation with abscess formation exists, the proper treatment is drainage of the abscess with later resection of the affected bowel and end-to-end anastomosis; or one of the many methods suggested, such as that of Paul, Tuttle, and others, whichever may seem wise in the operator's judgment, may be followed. If obstruction exists at the time the patient comes under observation, the procedure to be followed will depend to a great extent on the location of the obstruction and the condition of the patient. We believe that relief of the obstruction by an ileostomy, with subsequent operation for the removal of the inflammatory mass, is preferable to doing the entire operation at 1 sitting. In a case of general peritonitis, bringing the ruptured bowel into the wound, doing away with the source of infection, drainage, putting the patient in the Fowler position, followed by a continuous Murphy drip, should be the logical procedure.

If the infection is of a low grade, then we have a proliferation of tissue with tumor formation. The treatment under such circumstances is the same as that followed in hyperplastic tuberculosis or cancer.

COLITIS

Various infections of the bowel, all referred to as colitis caused by different organisms, cannot be classified until such time as the various organisms that cause the infection are isolated. Ordinary mucous colitis or membranous colitis due to local irritation, adhesions, and inflammation, such as a chronically inflamed appendix, adherent gall-bladder adhesion between the tubes and ovaries, etc., is easily cured by removing the cause of the trouble.

A very interesting case, and only one of a number that have recently come under my observation, was that of a young girl, a school teacher, who had suffered from a severe colitis for 15 years, with nervousness and all the other symptoms that accompany such disturbances in the colon. All was relieved within a very short time after the removal of an inflamed appendix, which was adherent to the ascending colon. Another case was that of a woman with a colitis which was relieved within a short time after the gall-bladder, which was inflamed and adherent to the transverse colon, had been removed. We could cite numerous such instances, but space does not permit.

There are other forms of colitis due to a streptococcus or staphylococcus infection, and others due to an infection by the ameba of dysentery, all of which are sometimes relieved by irrigation of the bowel; but, when chronic, require surgical measures such as appendicostomy, cecostomy, or ileostomy; but the most intractable of all are the so-called acute or chronic groups of hemorrhagic infections of the colon.

Hemorrhagic Colitis

Hemorrhagic colitis is a rare, extremely serious, and, from the few recorded cases, I should say fatal disease. It appears to be an infection of some sort, probably due to bacteria that come in intimate contact with the cells, causing a resulting chronic, diffuse, hemorrhagic inflammation of the colon; but, curiously enough, it seems to stop abruptly at the ileocecal valve. It occurs in young adults and comes on suddenly without any apparent cause. The characteristic symptoms are continuous and sometimes profuse loss of blood with diarrhea. It is usually preceded by abdominal pain or some stomach disturbance, as in my own cases. The amount of blood lost in some cases is considerable, and after a while the patient becomes very anemic; occasionally the pulse is rapid and almost imperceptible; the temperature is high, and in numerous cases has reached 109° F. The blood is ultimately mixed with pus which has a foul odor and is occasionally passed in large quantities, as if an abscess had ruptured; the amount of pus passed varies, sometimes being scanty, with very little odor; at other times the odor is pronounced and the quantity large, with clotted blood.

Treatment.—The treatment, as successfully employed by me, is as follows: First of all, putting the colon at rest by means of an ileostomy or cecoileostomy and subsequent irrigation of the bowel with zoölak and subnitrate of bismuth.

HIRSCHSPRUNG'S DISEASE

Congenital dilatation of the colon has been described by Finney (4). In his article he has brought the entire subject up to date.

Symptoms.—Constipation, pain, periodic attacks of vomiting, and in some cases an obstruction are the symptoms.

Treatment.—Laparotomy with resection of the colon, either end-to-end, lateral, or after the method of Tuttle's 3-step operation, is the surest method of curing this disease.

CASE OF PERFORATION OF THE SIGMOID FLEXURE OF THE COLON, PROBABLY DUE TO THE IRRITATION OF THE FECES

A woman named M. H., age 42, died in St. George's Hospital, under the care of Dr. Barclay, October 28th, 1863. She had for some months before her admission suffered from constipation, and she described herself as of a bilious habit. She was attacked about a month before her death with pain and tenderness in the left iliac region, and she eventually sank with symptoms of circumscribed peritonitis.

At the post-mortem examination a partially empty cavity, as large as a cocoanut,

was found occupying the left iliac region of the peritoneal cavity. The front of this cavity was formed by the abdominal wall, the back by the bowels, which were matted together by firm lymph. The cavity contained pus and fecal matter. It communicated with the sigmoid flexure of the colon by means of some ulcerated perforations.

On laying open the intestine, about half a dozen ulcers became visible. These were oval like button holes, and of much the same size. They were all near together, parallel to each other, and transverse to the axis of the bowel. They looked as if a piece of the bowel had been cleanly pushed out. The muscular coat was more widely destroyed than the serous. There was no trace of tuberculous disease in the neighborhood. The only signs of morbid action in their vicinity were some transverse brown stains, occupying the transverse folds of the bowel, and looking as if they had been produced by contact with the feces. These, however, were smaller, did not correspond accurately with the ulcers, and from this specimen it was doubtful how far the ulcers and the brown stains were connected. The right kidney was atrophied, and contained tuberculous matter (22).

ACTINOMYCOSIS

Actinomycosis is a disease supposed to be due to an infection from carious teeth, contaminated water, and vegetables. About 20 per cent. of actinomycosis is intestinal. In 12 per cent. of these cases it is located in the cecum or appendix. The disease usually spreads through the circulation, rather than through the lymphatics. It is primarily local, but after a while it becomes general, and abscesses may be found in parts distant from the original focus. It is an extremely difficult disease to diagnosticate, and when diagnosed and treated surgically, only a small percentage of cases are permanently cured. Grill, in Dacosta's Surgery, says that of 77 abdominal cases treated surgically, 45 died, 22 recovered, and 10 improved.

Symptoms.—In 120 cases collected by Hinglais (11), the symptoms began with colicky pain, vomiting, and constipation, alternating with diarrhea—symptoms somewhat resembling appendicitis. The disease usually begins in the intestines as whitish patches in the mucosa, and these patches subsequently spread and sinuses are formed. In the region of the cecum a swelling may be the first symptom, and in such cases the tumor may be mistaken for carcinoma, for malignant tumor, tuberculosis, or diverticulitis.

Indications for Operation.—Operation is indicated by the presence of a tumor or symptoms pointing to an infection or a tumor of the colon.

Treatment.—The complete removal of the infected area is the ideal procedure whenever it is possible. When this is not possible, opening the local abscesses and a thorough cauterization of all infected tissues constitute a palliative measure worth consideration. When the cecum is involved, the cecum and ascending colon and part of the ileum should be removed with a side-to-side anastomosis made to the transverse colon and ileum, after the method of Bloodgood, with the ends of the stump brought outside of the peritoneum. This procedure gives excellent results. When the tumor is situated in the sigmoid, the 3-stage operation of Tuttle gives good results. When the transverse colon is involved, we have a much more serious problem to deal with, first, on account of the blood supply, second, on account of making a perfect approximation, and, third, on account of the proximity to other organs. Here, whenever possible, the procedure of Bloodgood should be followed, or some such method as suggested by Tuttle, Mikulicz, or Paul.

MUCOUS CYSTS

Mucous cysts, or cysts of the cecum are rare, and when present are only diagnosed on the operating table. A cyst may exist for a long time without causing symptoms other than an occasional colic, or pain in the region of the cecum. They are not usually palpable, because before they reach a size where palpation is possible, obstruction occurs, either from intussusception or as a result of direct blocking of the ileocecal valve.

"**Mucous Cyst of the Cecum in a Child Ten Weeks of Age, Producing Occlusion of the Ileocecal Valve, and Simulating a Case of Intussusception.** Resection of the Gut. Death on the Twelfth Day.

"The infant had been in good health for the first two months of its life, but since then had suffered from persistent vomiting. A sausage-shaped tumor, three inches in length by one in diameter, freely movable in the lower right quadrant of the abdomen, was recognized and immediate operation advised. Distinct peristaltic waves were recognized traveling toward the site of the tumor. At operation the tumor was found to involve the lower portion of the ileum and cecum. Above the mass the ileum was collapsed. Believing that it was an ileocecal intussusception careful efforts at reduction were made, but failed. A resection was performed with an end-to-end anastomosis and the abdomen closed. There were no symptoms of shock after the operation and for several days the condition was good. On the tenth day the pulse became weak, the face assumed an earthy hue, and the features became drawn. Death from peritonitis occurred on the twelfth day. The pathologist's report showed that the tumor consisted of the cecum with its contained cyst and the appendix. The cyst measured 2 c. c. in diameter and contained glairy mucoid material. It was situated on the wall of the cecum opposite the ileocecal valve, and obstructed the orifice. The cyst was regarded as a retention cyst arising either from faulty development or from inflammation and occlusion of the mouth of the original gland. No case similar to this had come to the attention of the author, though he had found two cases in the literature that had a certain similarity and several that had an associated interest as the clinical symptoms were similar, though the pathological findings were different" (1).

Dr. Blackader did not consider the possibility of this cyst being due to an inverted diverticulum with occlusion of the diverticulum at the peritoneal outlet. We mention this because we can see the possibility of such a course. The cyst was evidently situated at about the right diverticulum.

VOLVULUS OF THE COLON OR MECHANICAL ILEUS

By volvulus is meant a twisting of the colon on itself or on its mesentery. Clinically there are 2 forms, acute and chronic, depending on the degree of obstruction. It usually occurs in those cases where fusion has not taken place, or where there is an over-development of the bowel with a narrow mesenteric attachment, as, for instance, in the case of the sigmoid.

Cecum and sigmoid are 2 of the most variable organs in the body, and for this reason volvulus is apt to occur in these locations. It may, of course, occur in any part of the colon, but the cecum, sigmoid, and transverse colon are the more usual situations.

Symptoms.—The indications for operation are pain, coprostasis, nausea, vomiting, absence of temperature, and evidence of shock. The symptoms are those of intestinal obstruction. The pain is usually severe and comes on suddenly, with or without previous constipation. Following the first onset the coprostasis is pronounced, and very little if any flatus is passed. However, if enemas are given some fecal matter and gas may be passed. This very often deceives the physician, as he imagines the obstruction has been relieved when this takes place. The pulse at first may remain normal, but, as the obstruction becomes more pronounced, it increases in frequency and becomes feeble and small with general collapse, cold, clammy skin, and pinched features, leaving no doubt as to the diagnosis. In volvulus of the cecum, the pain may be referred to the left side either in the epigastric region or in the region of the sigmoid. In one case that came under my observation the onset was sudden, with severe pain over the region of the sigmoid, changing only a few hours before operation to the right side over the region of the cecum.

Bound volvulus is a term applied to a condition in which there is more than 1 twist, as, for instance, volvulus of the cecum and transverse colon. I have seen 1 such case, which is reported below:

F. J. M., Hudson Street, 19 years old, male.

Family History: Mother died at the age of 26 of an infection following premature birth.

Habits: Two cups of coffee, no tea. Smokes and drinks in moderation.

Jan. 29.

P. P. History: All the diseases of childhood.

Present Illness: He complained of cramps at breakfast, but went to business, nevertheless. During the day the pains grew worse, and he had to lie down. Returned home at 4 o'clock, was unable to work any longer on account of the continued pain. The pain was not so severe as to cause him to go to bed. Had supper at 7 P. M., 3 chops, a baked apple and a potato. He went for a walk after this, made some purchases and tried to forget his pain. He retired at 11 P. M., and thought that with the aid of a water bottle he would get along all right. He was in bed but a short time when the cramps became so severe that the doctor was sent for. The patient was very pale, and cold perspiration showed evidence of shock. The pains were in the left iliac fossa. He vomited 3 times, and the doctor gave him a hypodermic of morphin. This did not relieve his pain. At the same time he gave him a dose of castor oil, which he promptly vomited, followed later by a dose of salts, which also returned. Later on he gave him another dose, which was not retained either.

He applied hot applications to his abdomen, and gave him several doses of morphin hypodermatically, but nothing could relieve the patient. This state of affairs continued all night long until about 6 in the morning, when the pain diminished and he felt more comfortable. He had not moved his bowels or passed any gas.

He felt fairly comfortable Tuesday morning, had occasional colicky pains, but they were not severe enough to necessitate morphin.

I saw the patient at 7 o'clock Tuesday evening, in consultation with Dr. Brozier, of Hoboken. He was then fairly comfortable. The abdomen was not very tense; there was more rigidity of the right than the left rectus muscle. The pain and tenderness seemed to be confined to the left iliac region. Nothing could be made out by palpation or percussion. The pulse was 72, the temperature normal, the respiration 24.

Examination through the rectum revealed nothing except a ballooning.

The patient was given a normal saline enema, in the knee-chest posture, and the result was good. He passed considerable gas, and quite a little fecal matter.

The parents were advised to remove the patient to Miss Alston's Hospital, so as to have him under our observation. He arrived there about 10 o'clock, in good condition. His pulse, temperature and respiration were normal. He was given an alum enema, and passed some gas and fecal matter.

The protoscope was passed, but revealed nothing except a ballooning and congestion of the rectum. He was suffering very little pain.

At 12 o'clock his temperature went up to 101, his pulse to 107 and his respiration to 30. The pain was located on the right side of the abdomen, principally over McBurney's point, and a distinct mass could be palpated in this same region. It was now decided to operate.

First Operation: A Battle incision was made. On reaching the peritoneum, it was found intensely congested, and on opening it, a muddy fluid exuded in large quantities. The portion of the bowel underneath the incision was enormoüsly ballooned, congested, cyanotic and covered with fibrin.

On passing the finger down, the cecum, appendix, colon, and ileum could not be located. The finger was now swept around to where the ileum should be, and followed the distended bowel up until the under surface of the liver was reached. It was found that the cecum and appendix were adherent to the under surface of the liver by means of a plastic exudate. It was brought down to position, and in bringing it out the inner leaf of the mesentery was lacerated.

The wound was now packed off very carefully with warm pads, and the cecum, ileum, and colon pulled outside of the abdomen. The ileum and colon had one mesentery, which was very long, and allowed the whole thing to be lifted outside of the abdominal cavity. Everything was packed off very carefully, and an incision made in the cecum. Large quantities of fecal matter were removed. The colon was now washed out with warm saline solution until all the fecal matter was thoroughly removed. The gut was covered with pads wrung out of a hot saline solution. This was kept up for about 15 minutes, until the color of the bowel was fairly normal. The opening of the bowel was now closed by means of a clamp. All the soiled pads were next removed, and everything washed off with saline. Then the mesentery was repaired, clean towels applied, and the colon, cecum, and a portion of the ileum returned to the abdominal cavity. A long cigarette drain was placed on the outer side of the colon, where the mesentery had ruptured, and brought outside of the abdominal cavity. The wound was closed by means of through-and-through silkworm-gut sutures.

A large drainage tube was inserted through the opening in the cecum, and held in place by means of a few sutures. The peritoneum was closed around the cecum 1 in. from the opening, and the wound dressed in the usual way. The patient returned to bed. Pulse 108, temperature 101, respiration 30. He was put in the Fowler position, and the Murphy drip started through the drainage tube in the cecum. He spent a very comfortable night.

Second Operation. February 14th: Patient was given ¼ gr. morphin, and 1/150 gr. hyoscin 3 hours previous to operation. He was brought into the operating-room at 8:10. Gas and ether anesthetic. The cecostomy opening was temporarily closed by means of collodion and cotton. The abdomen was washed off with alcohol, and afterward painted with tincture of iodin. Incision was made about 3 in. long on the outside of the left rectus muscle. The entire colon was examined, which could be easily done, owing to the fact that it had a very long mesentery, but everything was so tied up by adhesions that great difficulty would have been encountered in breaking up those adhesions and subsequent adhesions to the small intestine might have occurred. The transverse colon was twisted and folded on itself. The descending colon, sigmoid, and transverse colon were all adherent to one another. It was, therefore, decided to establish a communication between the ileum and the upper portion of the sigmoid. Accordingly we performed an ileosigmoidostomy. The wound was closed in the usual manner.

The patient was allowed to sit up the second day after operation. No gas or fecal matter passed through the rectum; everything coming through the artificial opening.

Some fear was, therefore, entertained lest, owing to kinking or some other mechanical obstacle, the opening between the ileum and sigmoid was closed.

Saturday morning (the 17th) the finger was passed through the cecostomy wound, and after searching for some time the opening into the ileum was discovered. With my finger in the ileum, as a guide, I passed a rectal tube through the ileocecal valve into the ileum. Some saline solution was now allowed to flow through the tube. It passed out through the rectum with some fecal matter and gas, thus settling the question of the patency of the opening.

Under cocain anesthesia the opening of the cecum was closed. Twenty-four hours after operation the patient developed symptoms of intestinal obstruction, and it was, therefore, deemed advisable to reopen the opening in the cecum. This was done, and a large quantity of fecal matter washed out with saline solution. It was now decided to adopt some measures to drain the large intestine. A median incision and careful examination revealed the fact that it would be impossible to make an anastomosis between any 2 legs of the large intestine, as the transverse colon was so intimately mixed up with the small intestine and adherent that any effort to remove it would leave a raw surface which might result later in an obstruction. It was finally decided to anastomose the cecum to the sigmoid; accordingly I did a cecosigmoidostomy below the iliac opening. Patient made an uninterrupted recovery. Was out of bed 4 or 5 days afterward.

Treatment.—In localizing an intestinal obstruction, the plan of J. B. Murphy (20) should be followed. The abdomen is opened by a median incision and the cecum is explored. The cecum is exposed unless a contracted coil of small bowel is seen when the abdomen is opened. In the latter case the first point to seek is the valve, since the obstruction must be above this. When the valve is reached, following up the small coil, the ileum is explored, the small bowel is passed through the fingers, keeping the bowels all the time within the abdomen, so that nothing escapes through the laparotomy incision. By this plan one soon arrives at a point where the small bowel will not come out, or is constricted. The cause can then be easily figured out. If the cecum is distended, then find the sigmoid, which will be collapsed, and trace it up along the descending colon until the obstruction is found.

The surgeon must be guided to a great extent by the conditions which prevail at the time. If the patient is not in good condition, and if there is some doubt as to the advisability of a prolonged operation, a simple opening above the obstruction should be made and the patient allowed to recover before the subsequent steps are carried out. If there is simply a band of adhesions, after removing the band and replacing the bowel in its proper position, no further interference is necessary. However, it is well in most cases either to shorten the mesentery or in some way fix the organ to prevent a recurrence. From a surgical and anatomical standpoint, the shortening of the mesentery is perhaps the better procedure.

When there is some doubt as to viability of the intestine, a resection of the bowel with end-to-end anastomosis or bringing both ends of the bowel out after the manner of Paul or Bodine should be followed. In the case of the sigmoid, especially when the organ is over-developed, treating it after the manner of Tuttle in his three-step operation for cancer is a procedure that should have very low if any mortality. It is exceedingly safe, and though it may be troublesome for a time and cause the patient some inconvenience, he should not object when the safety to his life is considered.

INTUSSUSCEPTION

Intussusception occurs most frequently in children and is due to an effort on the part of the bowel to rid itself of some foreign body, whether a tumor or worms. I have seen 2 or 3 cases in children. In one a number of fibrous tumors were present. Whether these tumors were due to a puckering up of the bowel or were the cause or result of the intussusception, I am not prepared to say. Another very interesting case was due to an inflated right diverticulum of the cecum, resulting in intussusception of the cecum, appendix, and ileum into the ascending colon.

This child had been obstructed for a week, and at this time was in pretty poor shape. It was impossible to reduce the intussusception, so a resection of the ileum, cecum, and ascending colon had to be performed. The child died a few hours after the operation.

Another case was that of a man who had a complete intussusception of the sigmoid due to an adenoma at the apex of the sigmoid. When I saw him the tumor was projecting through his anus. The tumor was removed first and laparotomy performed afterward. Considerable difficulty was experienced in reducing the intussusception. After it was reduced, the sigmoid was fixed to the abdominal wall, and the patient made an uninterrupted recovery.

E. S. West (25) reports a case in a woman 30 years of age, due to a growth. The operation was successful.

Hohmeier (12) reports an intussusception in a woman of 66, due to a lipoma of the lower end of the ileum. The ileum passed through the ileocecal valve carrying the valve into the cecum.

C. U. Collins (4) had a case of a woman 50 years old in which the intussusception was due to a lipoma of the cecum about 2 in. in diameter. The patient recovered after operation.

C. J. Miller (19) had a case in which an intussusception of the cecum and ileum was produced by a sarcoma in the valve. The patient died after the operation.

Indications for Operation.—Indications for operation are pain, coprostasis, distention, vomiting, and other symptoms of obstruction.

Treatment.—Laparotomy should be performed as early as possible. The median incision is preferable, as the entire abdomen can be explored in this manner. The intussusception should be reduced if possible. When it cannot be reduced, a resection of the involved bowel should be performed and the subsequent treatment is the same as already described for volvulus.

ADHESIONS, KINKS, ETC.

Adhesions and kinks may be either congenital or acquired. A great deal has been recently written on kinks of the ileum, so-called Lane's kinks, the veils of Jackson, and those other congenital anomalies which are due probably to a reduplication or imperfect approximation of the different layers of the peritoneum during the evolution of the fetus. Adhesions may form in any portion of the intestinal tract, but they are particularly liable to happen in certain locations around the cecum and the lower portion of the ileum, the hepatic flexure, the transverse colon, the splenic flexure, and most frequently in the sigmoid.

I have seen cases illustrating nearly all the conditions mentioned, but one in particular is of sufficient interest to demand passing notice. It occurred in a woman who had been previously operated on and was due to a complete rotation of the omentum, causing a volvulus of the transverse colon. Figure 13, A illustrates this case.

In another case the gall-bladder was adherent to the transverse colon, and the patient was relieved by breaking up the adhesions.

There are many instances where the sigmoid becomes adherent to the tube in the female. On account of the proximity of the female generative organs to the sigmoid and the frequent inflammations which result from infection of those organs, adhesions are very apt to occur between these structures.

Symptoms.—The symptoms are usually those of mild obstruction with constipation and auto-intoxication. Reflex stomach symptoms may overshadow everything else, so that the diagnosis of lesion of the stomach is made, when in reality stomach symptoms are only secondary or reflex, and the real cause of the trouble is in the colon.

Treatment.—The treatment of these cases will depend to a great extent on the conditions found at operation. If due to simple bands or adhesions which can be broken down, the raw surfaces being covered with peritoneum, this treatment alone is sufficient. In some cases the kinks or adhesions are so extensive as to demand resection of the bowel or short circuiting. Both of those operations have already been described.

ENTEROPTOSIS

This condition was first described by Glenard, and has received a great deal of attention recently from such men as Coffey, Lane, Bloodgood, Satterlee, and others. Enteroptosis is usually congenital, and one can easily diagnosticate those cases from a casual inspection of the patient. Such individuals have an acute costal angle, long narrow chest and scaphoid abdomen. In the majority of cases simple medical treatment and rest, with forced feeding, will be sufficient to relieve these individuals, but there are some cases where medical treatment fails and where some surgical measure has to be considered for the correction of this deformity.

These are the cases that are referred to here. Many operations have been suggested, such as removal of the colon, either partial or complete, short circuiting, with or without removal of the colon or the suspension of the colon, shortening of the gastrohepatic ligament, etc., but the operation suggested by Doctor Coffey has, in my estimation, given the best results. These cases should be very

Patient	Age	Social Status	Chief Complaint	Secondary Complaints	Date of Operation	Operator	Results of Operation
D. 1	44	M	Mental distress	Headache, tremors, constipation	7/1913	Draper	Freedom from symptoms
D. 8	30	M	Vomiting	Eructations, flatulence, constipation xx, diarrhea, headache, pains over body, X-ray, G. C. 2½" below, P. A. 6½"	7/1914	Draper	Relief of symptoms
V. 1	33	M	Pain	Constipation, diarrhea, nausea, rectal discharge	6/30/14	Lynch	Freedom from costive symptoms
B. 1	47	S	Vomiting	Constipation, nausea, pain, blood pr. 168, X-ray, G. C. 6" below	3/30/14	Draper	Relief of symptoms blood pr. 140 X-ray, G. C. at umbilicus
S. 9	40	S	Dragging sensation	Vomiting, constipation, loss of wt., X-ray, G. C. 6" below, P. A. 6"		Douglas	Cured 2 years post-operation

The operation performed in each case was the Coffey suspension, modified by scarifying peritoneum to expose fascia transversalis. "S", "D", "V", "B" indicate Drs. Satterlee, Draper, Vail, and Barber, respectively, of New York.

G. C. = Greater Curvature. P. A. = Pyloric Arm. wt. = weight. xx = pronounced.

The author is indebted to Dr. Barber for compiling these cases.

carefully selected, and operation should not be undertaken except where medical treatment has entirely failed.

Sufficient time has not yet elapsed to determine absolutely the value of the Coffey operation, but so far as we can see in the 20 cases upon which we have operated, the results are all that could be desired, but we must withhold judgment until many years have elapsed and those patients have been under observation for a long time, before we can determine absolutely the value of surgery in this congenital deformity.

Results from cases operated on in the Clinic for Gastrointestinal and Rectal Surgery are as cited above.

TUBERCULOSIS

Tuberculosis of the colon is divided into the ulcerative, hyperplastic, and miliary types. Primary tuberculosis of the bowel is exceedingly rare. It is usually secondary to a focus in some other part of the body—as a rule, the lungs. For this reason, when patients acquire tuberculosis of the bowel, very little can be done in a surgical way because of the impairment of the general health.

Primary tuberculosis occurs in from ½ to 1 per cent. of all cases of tuberculosis of the bowel. In 1,230 autopsies at the Royal Victoria Hospital in Montreal, tuberculous lesions were found in 285 cases, but only 2 were undoubted instances of primary intestinal infection. From the statistics of Park and Krumweide, of the New York Board of Health, it would appear that bovine tuberculosis is responsible for a large percentage of infections of the intestinal tract in children under five years of age. This can be accounted for by the fact that milk forms the bulk of the diet of children at this age.

Ulcerative Tuberculosis

Symptoms.—Diarrhea is the most constant symptom in the ulcerative type of tuberculosis. At first this may be slight, but as the ulceration increases, the desire to empty the bowels becomes more imperative and frequent.

The earliest symptom to attract the attention is the passage of gas and mucus with irregular colicky pains and tenderness. This is followed later by blood mixed with mucus. Occasionally severe hemorrhages result from erosion of blood vessels.

Treatment.—When the ulcerative tuberculosis is limited to the cecum or ascending colon, removal of the involved bowel has occasionally given very good results. When the infection is fairly generalized but limited to the large bowel, an ileostomy, in my opinion, has given the most gratifying result. This operation has already been described on page 419.

Some writers prefer an appendicostomy to an ileostomy, but that is because they have had very little experience with an ileostomy. I cannot see any great advantage to be derived from an appendicostomy unless there is stenosis of the bowel close to the rectum; otherwise it is just as satisfactory to irrigate from below as from above. In all cases the patient should be put under the best hygienic surrounding, with absolute rest in the open air, and a light and nutritious diet.

HYPERPLASTIC TUBERCULOSIS

This form of tuberculosis is the result of an attenuated infection producing a proliferation rather than a destruction of the tissue. It is very often mistaken for cancer, diverticulitis, and ordinary stenosis. The great difficulty in distinguishing this form of tuberculosis from other inflammatory conditions is due to the fact that the tubercle bacilli are very hard to find and the diagnosis in the majority of cases is made from the giant cells with the nuclei peripheral and in the shape of a horseshoe. This is not entirely satisfactory, as one must realize that giant cells are frequent in this region on account of the constant irritation.

Symptoms.—The symptoms are, usually, gradually increasing constipation with the passage of mucus, and later pus, mucus, and blood. The patient has a desire to move the bowels frequently, with a feeling of unfinished stool. There are usually loss of weight and the presence of a tumor.

Treatment.—Treatment of this form of tuberculosis is entirely surgical, and consists in the removal of the involved bowel with an end-to-end or end-to-side anastomosis, or by the 3-step method, each of which has already been described.

MULTIPLE POLYPOSIS

Multiple polyposis is much more frequent than is generally supposed. I have seen 18 cases in all.

Symptoms.—Constipation, alternating with diarrhea, passage of blood and mucus, loss of weight, and anemia are the usual symptoms.

Treatment.—There are only 1 or 2 instances on record where a cure has been obtained by medical means. We are of the opinion that this condition demands surgical interference. The best results are obtained by performing ileostomy, putting the bowel at rest, and irrigating the aboral end with salicylate of bismuth. Under this form of treatment all the patients have gained in weight, and, so far as we can see, the tumors have entirely disappeared.

FOREIGN BODIES IN THE RECTUM AND COLON

Foreign bodies find their way into the rectum in divers ways. In the majority of cases they are taken into the stomach, passed through the intestinal tract, and become implanted in the anus. In other cases they are introduced as a result of accident or design. In the case of young children, who are in the habit of swallowing everything they pick up, it is astonishing that those bodies do not oftener become implanted in the outlet of the bowel; but presumably an explanation can be found in the fact that they are covered by fecal matter, and so pass out without causing injury.

Pilcher reports a case of a woman suffering from melancholia, who swallowed a number of foreign substances with the object of doing away with herself. She subsequently passed nineteen nails, a screw, some pieces of earthenware and glass, a piece of whalebone, part of a needle, and 2 knitting needles.

It was the custom for the natives of Balasore, on the Bay of Bengal, to put a dried clay plug in the rectum after moving the bowels. This was removed before the bowels moved again and a new one adjusted. (Ball.)

Pierra (22) reports a very interesting case in which a stick, 9½ in. long and 1½ in. in diameter, was passed into the rectum. It was subsequently removed without very much damage.

The rectum is frequently used as a storehouse for precious stones and jewels. In South Africa, the Kaffirs often swallow, or secrete in the rectum, valuable diamonds. It is customary in the mines to strip the Kaffirs and search them after a day's work. In other cases, if there is any suspicion, they are given a cathartic and the stools passed through a sieve. Often diamonds have been recovered in this way.

There are innumerable cases on record where all kinds of foreign substances, from bottles to pins, have been introduced into the rectum. These conditions, however, are rare and not worth enumerating. The cases which the majority of surgeons are called upon to treat are cases where small foreign substances have been swallowed, such as fish bones or needles, and then become implanted in the anus.

Foreign bodies are most frequently found in the little crypts or pockets of Morgagni which surround the anus and offer an obstruction to the exit of foreign substances.

Foreign bodies may be swallowed and fecal concretions form around them, resulting in intestinal obstruction. This is particularly apt to be the case if the individual suffers from angulation, stricture, or tumor. One such case came under my observation—a case of stricture—where the patient had swallowed a plum pit, resulting in intestinal obstruction. There are people who have the habit of chewing hair, and cases are on record where this habit has resulted in the formation of a foreign body, either as a result of the hair or of fecal concretions around the hair mass.

Symptoms.—The symptoms, to a great extent, will depend on the location of the foreign substance and the amount of damage done. If the foreign substance causes a perforation, the early symptoms are those of peritonitis, and the severity of the peritoneal infection depends upon where the foreign body perforated. If the perforation occurs near the stomach, the symptoms are not so pronounced as if it had occurred in the lower ileum or sigmoid, where bacterial life is more abundant and virulent. However, peritonitis results in either case, but the degree of infection is greater below than above. On the other hand, if the body is large and obstruction results, the reverse happens, as the higher the obstruction, the more fatal the result.

In the majority of cases foreign substances are located in the anus, and if they are not discovered early, abscess usually results. In such cases, the symptoms are those referable to an abscess. The severe pain during defecation compels the patient to seek a doctor, and a local examination reveals the diagnosis. As fish bones are the most frequent foreign substances swallowed, they are usually arrested in the crypts, causing severe pain, and, as a general rule, are recovered before much damage is done. A sharp, shooting or stabbing pain, especially during the movement of the bowels, is the most pronounced symptom of the presence of a foreign body. I saw one case in which this was the only symptom. I subsequently removed a needle in this case, after which the patient had no further inconvenience.

An abscess may be the earliest symptom, but, in the majority of cases, there is some previous indication. In some cases there is tenesmus, with a desire to move the bowels, followed by an increase of pain. In other cases the symptoms have been those of an ulcer, with the occasional passage of a little blood. If the foreign body is very large, pain in the pelvis, with obstruction, may be the first indication. Some of the other symptoms are dull, aching pain, aggravated by motion, sitting, or any pressure on the perineum. Movements of the levator muscle will increase the pain, causing a spasm in some cases. Constipation may be the only symptom, and is due either to the foreign body causing the spasm in the colon; to the pain resulting from defecation, or to ileus resulting from severe pain.

Other symptoms are dysuria, cystitis, neuralgia, sciatica, pain in the back, a bearing down feeling, with prolapse of the bowel, bulging of the vagina or perineum, and hemorrhage. In one case that came under my observation the foreign body perforated the bowel, lodging around the sacro-iliac joint and resulting in very severe sciatica.

Complications.—Abscess formation is probably the most frequent complication following the presence of foreign bodies in the anus. The abscess, if not properly treated, may terminate in a fistula. Suppuration, with inflammation between the rectum and other organs, occasionally happens. If the foreign body is large and situated in the colon, rupture may result. Such cases have been reported—rupture of the sigmoid. Of course, a perforation of the colon is much more serious than perforation of the rectum. Intestinal obstruction, either acute or chronic, should also be considered as a complication of foreign bodies.

Diagnosis.—The diagnosis of foreign bodies depends to a great extent on their location. If situated in the anus, they can be easily reached by the finger, but it may require an anesthetic in order to make a satisfactory examination. When situated higher up, the diagnosis can usually be made by the X-ray, and in one of my cases I was able to locate the foreign body before operation by this method.

Treatment.—The treatment of foreign bodies depends to a great extent on the location and nature of the foreign substances we are dealing with. When they are situated low down in the anus or in the rectum and are not too large, they can be conveniently dealt with when the patient is under a general anesthetic.

Sometimes the foreign substance is quite large, especially in cases where bodies have been introduced from below, and in some cases where bottles and glass have found their way into the rectum it has required a great deal of skill and ingenuity to extract them without serious damage to the surrounding tissues. When difficulty is experienced in delivering the body through the sphincter, it is much safer to cut the muscle than to overstretch or tear it during delivery. The little semilunar valves occasionally contain foreign substances, such as pins, fish bones, and beads, and it may not always be easy to locate them.

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CHAPTER IX

APPENDICITIS

WILLIAM DARRACH

INDICATIONS

Acute Appendicitis.—In acute appendicitis early operation is the safest form of treatment. If there are no good contra-indications, it should be performed as soon as the diagnosis can be made. The "interval operation" or removal of a quiescent appendix, gives the lowest mortality, but the death-rate following operation performed during the early stage of the disease is very little higher. So it is unwise to run the risk of allowing the process to go on to gangrene or peritonitis, in the hope that the attack will subside. If the patient is seen during the first 24 hours and the attack is of a *mild* type, a 12-hour delay *may* be granted. At the end of that time operation should not be further delayed unless *all* of the symptoms are becoming less pronounced. If any one symptom is increasing in severity, delay is unwise. If all cases of acute appendicitis could be operated on within the first 24 hours, the mortality from this disease would be very small. The laity is learning the wisdom of early operation and its value is being appreciated by the medical world, and if this progress continues appendiceal peritonitis will soon become as infrequent as puerperal sepsis. In early operations for definite symptoms of acute appendicitis, the surgeon is often surprised at the severity of the lesion and rarely at its mildness. The intensity of the symptoms is such a poor indication of the character of the lesion that it is impossible to foretell with surety whether any given attack will subside or not. Nor is there any single symptom which will guide us. Localized tenderness is perhaps the most constantly present sign, but this may be well around in the loin, under the costal margin or in the left lower quadrant. There may be no nausea and no vomiting. Rigidity may be completely absent if the inflamed appendix is concealed from the peritoneum by overlying omentum or because of its retrocecal position. The sequence of the onset of symptoms is of great importance, for in acute appendicitis they almost always follow a given order: pain, nausea and vomiting, tenderness and rigidity, slight fever and leukocytosis. In a mild case the symptoms will often subside if the patient is put to bed with an ice cap over the right lower quadrant of the abdomen and given absolutely nothing by mouth. But operation should be immediately advised if there is a reappearance of the symptoms or an increase in their severity when he takes any food, takes a cathartic or begins to be up and around.

When the disease has progressed to abscess formation or peritonitis, immediate operation is also indicated. If drainage can be provided rapidly, whether the appendix is removed or not, there will be a better chance of recovery than with the non-operative measures of starvation and opium. Even in the very advanced cases a quick operation offers a little hope.

In brief, the indications are to operate as soon as the diagnosis of acute appendicitis can be made.

Recurring Appendicitis.—When the patient has had a number of acute attacks and comes for advice during the quiescent period, a great deal will have to depend on the history. He should be most carefully questioned as to the details of each attack—the onset, the sequence of events, site and character of the pain and tenderness, both during the early hours and after they have become localized, and the association of nausea and vomiting. The temperature and blood picture should be inquired after, if they were investigated during any of the attacks. The diagnosis can often be substantiated by the persistence of some tenderness in the region of the appendix. If pressure over this area causes epigastric pain, it is quite significant. Another suggestive sign is when pain, referred to the site of the appendix or to the epigastrium, is elicited by pressure over the transverse and ascending colon, against the current, forcing gas down into the cecum. Other possibilities must always be considered, such as renal or ureteral colic, gall-stones and peptic ulcer, and every endeavor should be made to eliminate these conditions by X-ray and other examinations. When the history evidently shows 1 or more definite attacks, and especially if examination at the time of the attack showed distinctly localized tenderness with rigidity and the blood picture of inflammation, operation must be advised. The patient should be told of the possibility of his never having another attack and also of the distinct risk of the operation (about ½ per cent. in interval cases); but it must also be emphasized that the dangers and mortality of the more severe cases far outweigh these arguments. If he is to remain near enough to proper surgical care, so that he may receive attention within the first 24 hours of his next attack, delay may be granted if he thoroughly understands the risk. But if he is to be away for any length of time, as on a trip to the woods or on the ocean, he should submit to operation before leaving.

Chronic Appendicitis.—In chronic appendicitis, when there has been no definite, acute attack, the question is more difficult to decide. The patient may have merely had what he calls "bilious attacks" or "colic" or "intestinal indigestion." The picture presented by a chronically inflamed appendix may so closely simulate gall-stones or peptic ulcer that the diagnosis can only be cleared up by exploration of both regions. As these 2 lesions frequently co-exist, the surgeon should never rest content after 1 region alone is exposed if there is any question of the diagnosis. The upper quadrant should be explored first through a small incision, splitting the right rectus near its lateral margin. If any lesion is found to exist in the gall-bladder or ducts, duodenum, pancreas or stomach, the incision can be enlarged and the necessary procedure carried out. If the exploration is negative, the small wound is closed. If the branches of the intercostal nerves have not been divided and the muscles and aponeurosis are carefully sutured, the abdominal wall will not be weakened. The appendix is then exposed and removed through the customary incision. If an attempt is made to accomplish all this through 1 incision placed midway between the 2 regions it often will prove successful. But only too frequently will it prove an awkward and difficult approach to both regions, adding to the trauma and time of the operation. The after-effect on the strength of the abdominal wall is more harmful than that of the 2 smaller incisions. The simulation of a right upper quadrant lesion by a chronic appendicitis is often proved by the disappearance of these symptoms after removal of the appendix.

The "intestinal indigestion" cases, with chronic constipation, flatulence and occasional colic and general poor health, will usually show at one time or another a little appendicular tenderness. When such cases fail to improve after carefully planned and executed conservative measures, and other conditions can be excluded, an appendicectomy is frequently indicated.

Another indication for removal of the appendix is when, during the course of some other abdominal procedure, this organ is found to be diseased, kinked or twisted, and its removal will not unduly add to the operative risk. In repairing a right inguinal hernia, it is often easy to bring the cecum and appendix out through the internal ring. If this can be done without undue traction and there is evidence of a pathological condition, the appendix should be removed. If, however, much traction is required to hold the cecum and mesentery in the wound, they should be replaced and a separate incision made at the usual site.

ANATOMICAL POINTS

Development.—In order to properly understand the various positions, the arrangement of the blood supply and the peritoneal relations of the appendix, it is necessary to consider the growth of the intestinal canal.

FORMATION OF THE UMBILICAL LOOP.—The early straight intestinal tube runs in the long axis of the body cavity and is attached to the midline dorsally throughout its whole extent by a double layer of peritoneum, the dorsal mesentery, which contains its blood, lymphatic and nerve supply. Increasing in length more rapidly than the body cavity, the so-called umbilical loop is formed with a proximal or descending limb and a distal or ascending limb (Fig. 1). Of these 2, the proximal limb grows more rapidly and becomes convoluted and coiled, forming the jejunum and the major part of the ileum. About the sixth week the cecal bud appears in the distal limb a short distance up from the apex of the loop. The rest of this limb forms the ascending and transverse colon (Fig. 2). Coursing down the center of the mesentery of this loop are the superior mesenteric vessels, with branches to each of the limbs. Those to the proximal limb become the vasa intestini tenuis, those to the distal limb the middle colic, the right colic and the ileocolic. The extremities of this loop remain near together throughout, the space between them being called the duodenocolic isthmus.

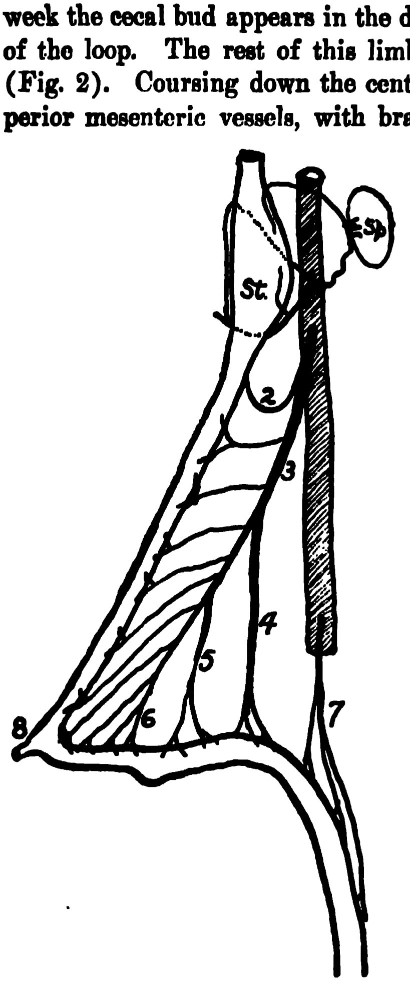


FIG. 1.—DEVELOPMENT OF INTESTINAL CANAL WITH FORMATION AND ROTATION OF UMBILICAL LOOP. EARLY STATE OF UMBILICAL LOOP. St., Stomach; Sp., spleen; D, duodenum; P, pancreas; A, aorta; 2, inferior pancreaticoduodenal artery; 3, superior mesenteric artery; 4, middle colic artery; 5, right colic artery; 6, ileocolic artery; 7, inferior mesenteric artery. (After Huntington.)

ROTATION OF THE UMBILICAL LOOP.—The next change that takes place is a rotation of the whole loop around an axis running from the duodenocolic isthmus to the apex, the distal limb passing sinistrad, then ventrad and later cephalad and dextrad till the ileocecal junction comes to lie in the right upper quadrant, just beneath the liver, while the coils of the jejuno-ileum pass caudad and sinistrad, dorsal to the distal loop. The transverse colon thus comes to lie across the duodenum, whose termination appears from beneath its mesentery (Figs. 3, 4). After reaching its subhepatic station, the ileocecal junction gradually attains a more caudal position by further lengthening of the ascending colon, till it finally rests in the right iliac fossa (Fig. 5). The branches of the superior mesenteric vessels to the proximal loop now pass sinistrad, while those distributed to the distal loop pass either dextrad (right colic) or ventrad (middle colic).

RELATIVE GROWTH OF THE CECUM AND APPENDIX.—Starting as a lateral bud from a straight tube, the cecum gradually lengthens and enlarges with the rest of the large intestine. At the same time its axis straightens out with that of the proximal colon until the entrance of the ileum into the colon becomes a right-angled one (Figs. 6, 7). At first a small conical blind pouch, this bud shows a marked difference in growth in its proximal and distal portions. The proximal portion keeps pace with the rest of the colon and becomes the adult cecum. The distal portion lags behind, remaining small, and becomes the vermiform appendix (Fig. 8). The proximal portion again is not symmetrical in its growth, but the development of the ventral and lateral portions is greater than that of the dorsal and mesial. The base of the appendix, therefore, is usually seen not at the apex of the cecal pouch but on its mesial or mesial and dorsal aspect. The relative preponderance of the growth of the lateral pouch over that of the mesial will determine the distance of the appendicular base from the ileocecal junction. It may be directly below or behind the ileocecal valve or anywhere between that point and the apex of the cecum (Figs. 8, 9, 10).

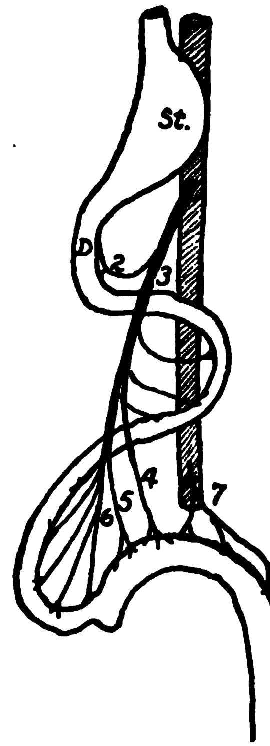


FIG. 2.—DEVELOPMENT OF INTESTINAL CANAL WITH FORMATION AND ROTATION OF UMBILICAL LOOP. BEGINNING COILING OF PROXIMAL LIMB. (After Huntington.)

SECONDARY ADHESIONS. The ascending colon and its mesentery now lie against the background of the abdominal cavity on the right side. The permanence of this position depends on adhesions which take place between the opposed peritoneal surfaces. This area of adhesions is triangular (Fig. 11) in shape. It is limited laterally by the outer margin of the ascending colon, mesially and caudally by the new dorsal attachment of the mesentery of the small intestine, and above by the dorsal attachment of the transverse mesocolon as far as the duodenojejunal angle. The latter boundary crosses, from without inward, the right kidney, descending portion of the duodenum and the head, neck and adjacent portion of the body of the pancreas.

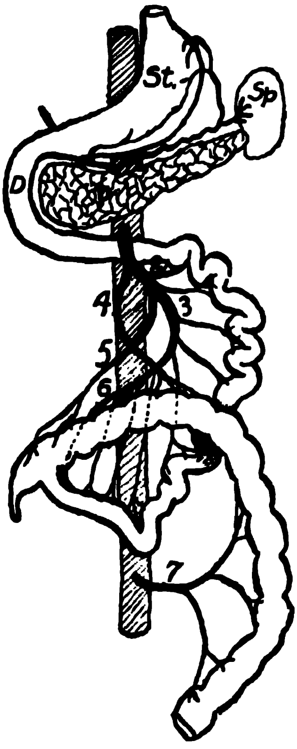


FIG. 3.—DEVELOPMENT OF INTESTINAL CANAL WITH FORMATION AND ROTATION OF UMBILICAL LOOP. BEGINNING ROTATION OF LOOP. (After Huntington.)

FINAL POSITION OF APPENDIX.—The ascending colon thus becomes a retroperitoneal organ and its vessels, instead of lying in a free mesentery, pass behind the dorsal parietal peritoneum. The final position of the cecum and appendix is influenced very largely by the time at which these secondary adhesions occur in reference to the descent into the right iliac fossa of this portion of the intestine. If the cecum and appendix complete their descent before adhesions have begun, the appendix will lie free, with its base a little below the ileocecal valve (Figs. 12, 13, 14). All portions of the intestinal tract tend to curve toward their mesenteric border and the appendix follows this rule, so that usually it will be found curving inward, to lie in the angle between the cecum and terminal ileum, perhaps under cover of the latter. A little less frequently it passes downward and inward, the distal portion hanging over the brim of the pelvis. Occasionally it turns outward, curling up behind and to the outer side of the cecum.

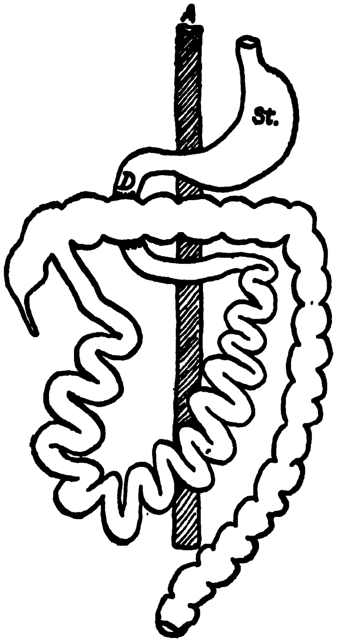


FIG. 4. — DEVELOPMENT OF INTESTINAL CANAL WITH FORMATION AND ROTATION OF UMBILICAL LOOP. FURTHER ROTATION OF LOOP, ILEOCECAL JUNCTION BEING IN SUBHEPATIC POSITION. (After Huntington.)

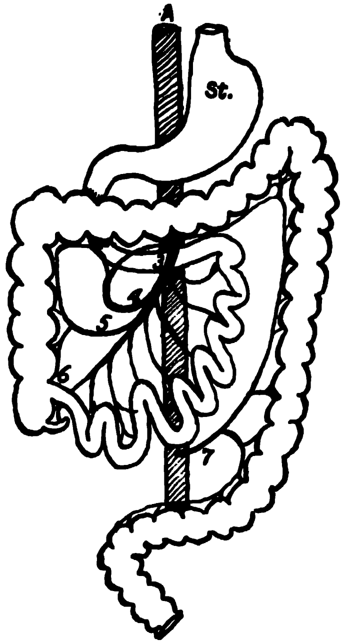
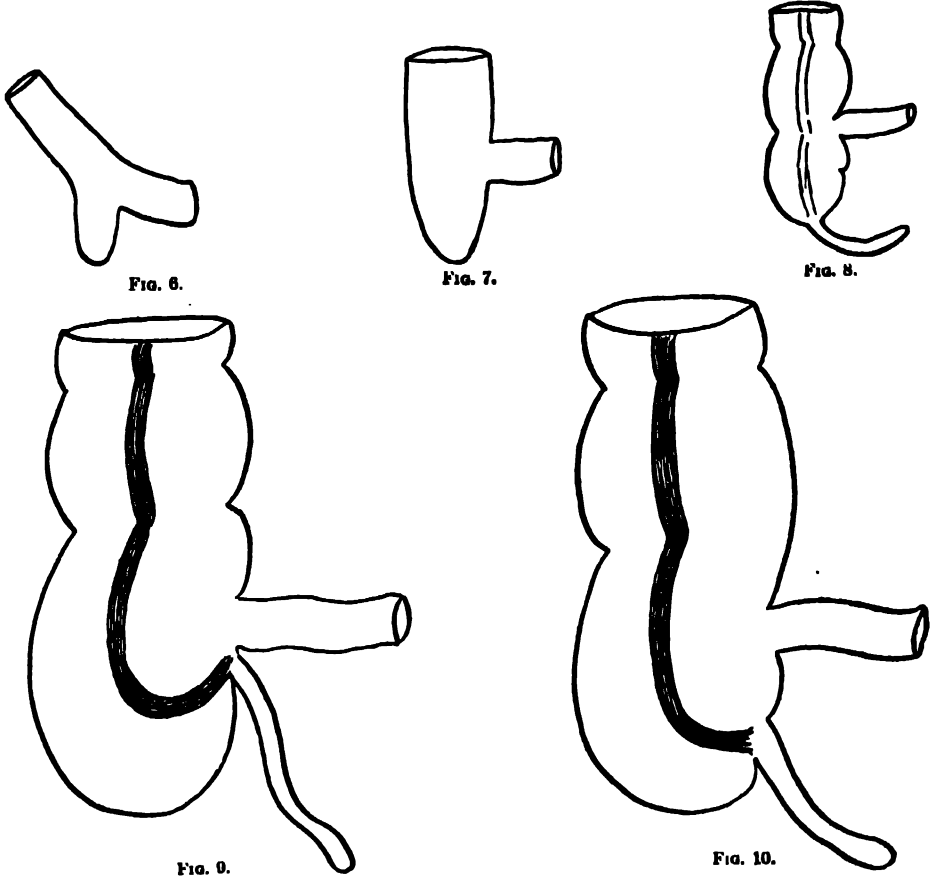


FIG. 5. — DEVELOPMENT OF INTESTINAL CANAL WITH FORMATION AND ROTATION OF UMBILICAL LOOP. AFTER DESCENT OF CECUM TO RIGHT ILIAC FOSSA. (After Huntington.)

If, however, adhesions begin to form before the descent is complete, the appendix may be caught up behind the cecum so as to lie in a retrocecal or even retrocolic position. An extreme example of this type is shown in Figure 15, where the base of the appendix became fixed early in a retrocolic position, the tip being vertically erect; the cecum rolls down in front, completely covering and hiding the base, and the terminal portion of the appendix remains free in the supracolic compartment under the liver. In Figure 16 the whole appendix is retroperitoneal; in Figure 17 it is retrocecal and retrocolic and adherent to the dorsal aspect of the colon but covered on its dorsal surface by peritoneum;

here the cecum can be freely lifted forward and upward; in Figure 18 it is again retrocecal and retrocolic, the base covered by peritoneum, the middle portion uncovered, while the tip projects into the supracolic compartment. The base and proximal portion of the appendix may be retrocecal, while its distal



Figs. 6–10.—Growth of Cecum.

Fig. 6.—Cecal bud from straight intestinal tube. Fig. 7.—Conical cecal pouch, with right-angled ileal entrance. Fig. 8.—Adult differentiation into appendix (distal half) and cecum (proximal half). Base of appendix near tip of cecum. Fig. 9.—Greater development of right cecal pouch. Base of appendix midway between apex of cecum and ileocecal valve. Fig. 10.—Preponderance of right cecal pouch. Base of appendix directly beneath ileocecal entrance. (After Huntington.)

portion passes caudad or caudad and mesad, appearing caudal or mesial to the cecum, and even dorsal to the terminal ileum (Figs. 19, 20, 21, 22). If the cecum fails to descend, it and the appendix may remain in the subhepatic position, the ileum entering the cecum from below, upward and outward.

If rotation of the umbilical loop fails to occur, the cecum and appendix will be found in the left lower quadrant, the ileum entering from the right to the left.

Thus it is seen that the final site of the appendix depends on all of the following factors: (1) rotation of the umbilical loop; (2) descent of the cecum from the subhepatic position to the right iliac fossa; (3) secondary adhesions between the opposed peritoneal surfaces; (4) the unequal development of the cecal pouches; and (5) the inherent curve of the cecum and appendix toward their mesenteric border.

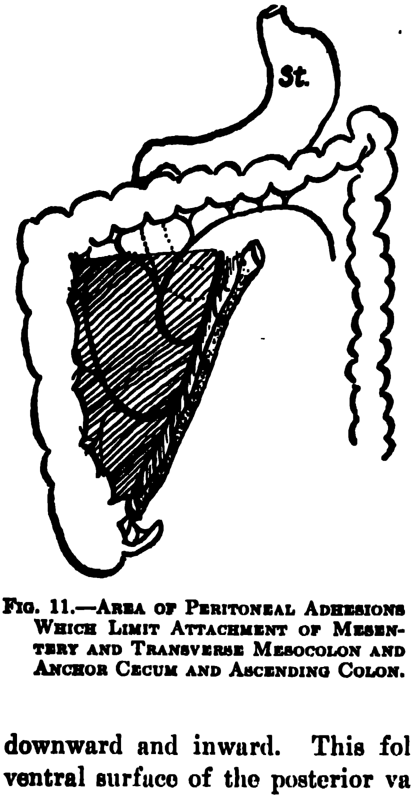


FIG. 11.—AREA OF PERITONEAL ADHESIONS WHICH LIMIT ATTACHMENT OF MESENTERY AND TRANSVERSE MESOCOLON AND ANCHOR CECUM AND ASCENDING COLON.

Peritoneal Folds and Vascular Relations.—The ileocolic branch of the superior mesenteric artery divides just above the terminal ileum into anterior and posterior branches (Fig. 23). The anterior branch is generally the smaller of the 2 and passes above the terminal ileum to the anterior surface of the cecum, where it is distributed. It lifts off the peritoneum into a slight fold, the anterior vascular fold (Fig. 24), whose free edge looks downward and inward and tends to inclose a shallow depression, the anterior ileocecal fossa. The larger posterior branch passes dorsal to the terminal portion of the ileum and usually divides into an upper branch, distributed to the inner side of the cecum, and a lower branch which supplies the appendix. This posterior ileocecal branch lies in a well-developed fold of peritoneum, the posterior vascular fold or mesenteriolum. In addition to these 2 vascular folds, there is a third, the intermediate or non-vascular fold, which passes from the non-mesenteric border of the ileum off onto the surface of the cecum, its free edge looking downward and inward. This fold usually swings off to blend in with the ventral surface of the posterior vascular fold, aiding in limiting the posterior ileocecal fossa. This fossa is bounded above by the under surface of the terminal ileum, laterally by the inner wall of the cecum, dorsally by the ventral surface of the posterior vascular fold and ventrally by the nonvascular fold. Its opening looks downward and inward. The terminal portion of the appendix is often found coiled within this fossa. In a small percentage of cases the anterior branch of the ileocolic artery will swing downward to supply the appendix.

Owing to the secondary adhesions of the dorsal surface of the colon and cecum to the abdominal background, the peritoneal covering of the intestine is reflected from the lateral and lower aspects of the intestine to become continuous with the parietal peritoneum. If the cecum is lifted forward, this line of reflection will be seen behind the cecum a varying distance from its apex. It may

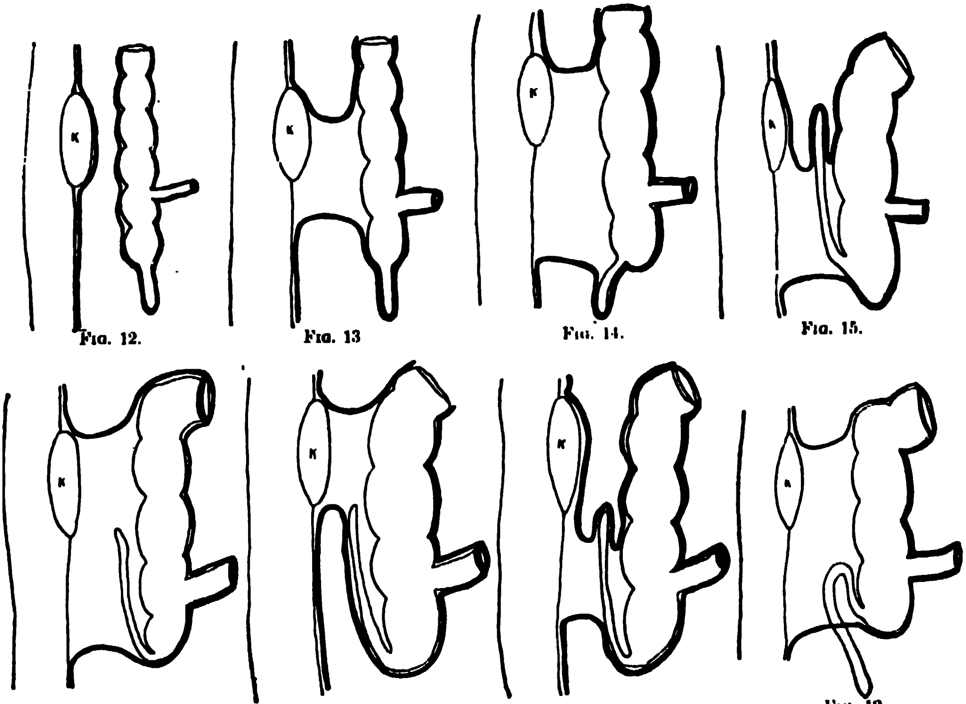


Fig. 12. Fig. 13 Fig. 14. Fig. 15.

Fig. 16. Fig. 17. Fig. 18. Fig. 19.

Figs. 12–19.—Diagrams Representing Sagittal Sections through Ascending Colon, Cecum and Appendix, Kidney and Back Wall. Heavy black line represents peritoneum.
Fig. 12.—Ascending colon, cecum and dependent appendix lying free. Fig. 13.—Ascending colon attached to back wall but cecum and appendix free. Fig. 14.—Ascending colon and cecum and base of appendix anchored to back wall, tip of appendix lying free. Fig. 15.—Appendix caught up behind colon, tip remaining free in supracolic compartment. Fig. 16.—Appendix entirely retroperitoneal. Fig. 17.—Appendix retrocecal and retrocolic but covered by peritoneum. Fig. 18.—Appendix retrocolic, base covered by peritoneum, middle portion retroperitoneal and tip projecting into supracolic compartment. Fig. 19.—Base and proximal portion of appendix retrocecal and retroperitoneal, tip hanging free. (After Huntington.)

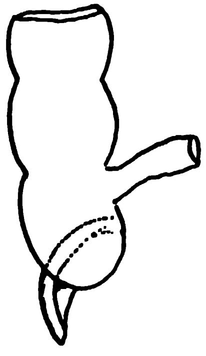


Fig. 20.—Same as Figure 19, Seen from in Front, Tip of Appendix to Right.

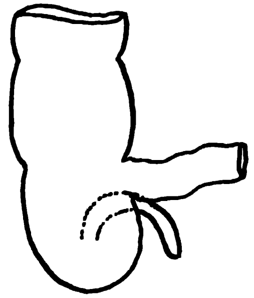


Fig. 21.—Same as Preceding Except Tip of Appendix is to Left.

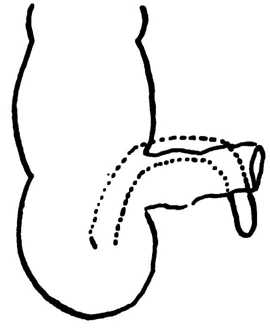


Fig. 22.—Same as Preceding Except that Distal Part of Appendix is up Behind Terminal Ileum.

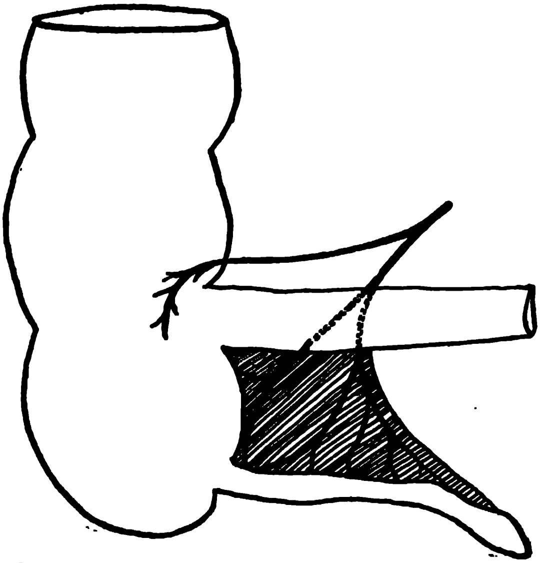


Fig. 23.—Course and Branches of Ileocolic Artery.

be a smooth, unbroken line, but more frequently it will be irregular, resulting in 1 or 2 peritoneal folds running from the dorsal cecal wall to the dorsal wall. These retrocecal folds inclose a fossa known as the retrocecal fossa. The distal portion of the appendix may be found curled up in this space.

The vascular relations of the appendix, when it is in a retrocolic position, are important from an operative standpoint. As the appendix becomes caught

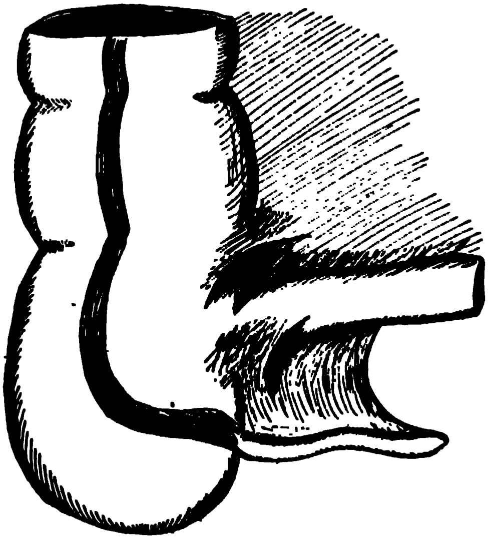


Fig. 24.—Ileocolic Region Showing Peritoneal Folds and Fossæ. Above the terminal ileum is the anterior ileocecal fossa limited by the anterior vascular fold. Below the non-vascular fold passing from the terminal ileum to blend with the posterior vascular fold or mesentery of the appendix, the two folds making the posterior ileocecal fossa.

up behind the cecum and ascending colon, its vascular mesentery is also held up dorsal to the ascending mesocolon. As adhesions take place, the mesenteriolum becomes buried and retroperitoneal, and superimposed upon the vessels of the appendix are the vessels of the ascending colon. The latter are thus endangered if an attempt is made to attack the appendicular vessels mesial to the colon (Fig. 25). If in such an adult condition the colon and cecum are mobilized by cutting the peritoneal reflection along the outer margin of the large bowel and the latter with its vessels is lifted forward and inward, the remains of the appendicular mesentery will be found dorsal to and free from the colic vessels (Fig. 26). Practically the retrocolic appendix usually lies so far to the outer side of the colon that its vessels may be easily reached without mobilizing more than the outer half or two-thirds of the colon.[1]

Position with Reference to External Landmarks.—After a consideration of the above it will be seen to be impossible to mark out a point on the surface of the body which will always correspond to the site of the base of the appendix, much less its distal portion. In the large majority of cases, however, the base of the appendix will lie within the region covered by a circle 2½ in. in diameter, the center of which is 1 in. below McBurney's point. This was described by him as a point 1½ to 2 in. from the anterior superior spine of the ileum on a line drawn toward the umbilicus. The distance between these 2 points, however, varies between 3½ in. in a thin, small person and as much as 12 in. on a large, fat abdomen. The junction of the outer and middle thirds of this line is, therefore, a safer criterion.

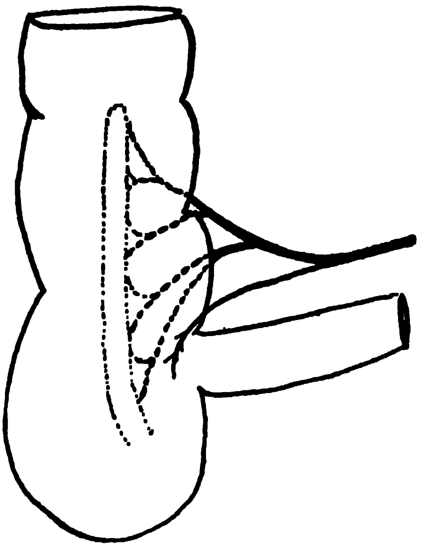


FIG. 25.—COURSE OF ILEOCOLIC ARTERY WHEN APPENDIX IS IN RETROCOLIC POSITION.

INSTRUMENTS USED IN OPERATIONS FOR APPENDICITIS

The following articles should be at hand:

2 knives.
2 pairs scissors curved on the flat.
2 pairs straight scissors.
2 pairs anatomical forceps.

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[1] This discussion has been largely taken from Huntington's "Anatomy of the Peritoneum and Abdomen."

2 pairs mouse-tooth forceps.
1 pair fine-pointed forceps (for invaginating stump).
6 skin clamps (for fastening towels to edge of wound).
6 artery clamps.
3 Kocher clamps with 2½ in. jaws.

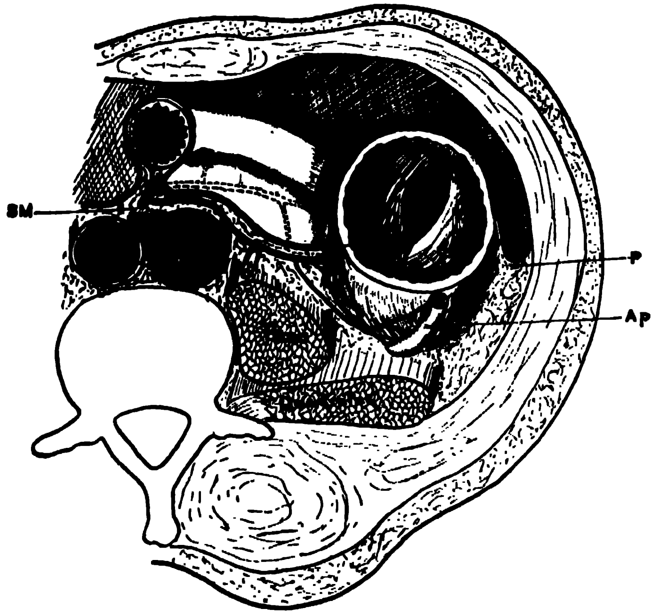

FIG. 20.—VASCULAR RELATIONS OF RETROCOLIC APPENDIX. Body cut across just above ileocolic junction viewed from above. A, Aorta; Ap, appendix lying behind the cecum and colon; I, terminal portion of the ileum; P, peritoneal reflection from lateral aspect of colon to lateral wall which must be cut through in order to mobilize the cecum; Sm, superior mesenteric artery giving off colica dextra and later appendicular vessel which is seen passing dorsal to colica dextra to reach the appendix; V.C., vena cava; U, ureter.

1 aneurysm needle or other ligature passer.
4 sponge-holders.
Retractors of various sizes (to suit abdominal walls of different thickness).
Self-retaining retractors (if preferred).
Actual cautery or carbolic acid.
Needles; straight and curved intestinal, curved surgical and skin needle.
Catgut, plain, numbers 1, 2 and 3; chromic, number 2.
Pagenstecher thread or silk.
Plate for appendix and soiled instruments.
Suction apparatus.
Drains.
Gauze sponges.
Gauze pads.
Split gauze pad.
Dressing, adhesive plaster, binder and safety-pins.

One of the most satisfactory **suction apparatus** is that described by Kenyon and Pool. (Chap. VII, Vol. I.) By means of this apparatus peritoneal fluid can be removed very quickly, thoroughly, and with little soiling, and the operation need not be entirely interrupted.

The **drains** most commonly used are rubber tubing, cigarette drains or combination drains. The rubber tubing should be soft enough not to imperil the wall of the intestine. This is best obtained by long boiling. Before using, each rubber tube should be pulled rather hard to test its friability, lest a piece come off and be kept inside, resulting in prolonged drainage or subsequent abscess. A fenestrated double tube will furnish the freest drainage and will often allow later irrigation. The cigarette drain is made of gauze, folded so there are no free edges and then pulled through a length of thin rubber cylinder. Cigarette drains can be made by wrapping the gauze with gutta-percha tissue. The cigarette drain is preferable when the oozing from a raw surface is a little too great to leave unprotected, and is preferred by many for all fluid drainage. An objection to the rubber tubing, although it allows freer drainage, is the danger to the gut wall from the pressure of the firm and often sharp edge of the tube. A combination drain avoids this and has the advantages of both. It is a double rubber tube, loosely wrapped with 6 or 8 layers of gauze and inclosed in another thin rubber cylinder, simply a double tube inside a cigarette. The gauze should come just to, but should not be allowed to cover, the lower openings in the tubing. This allows full drainage and protects the bowel from the stiff tubing.

The **sponges** and **pads** are made of gauze, so folded as to leave no exposed cut edges. The latter should be sewn to prevent unfolding, with a 12-in. tape securely fastened at 1 corner. The pads should be done up in packages of 6, and carefully counted by 2 people before and after the operation, to make sure none are left in the wound. A convenient grade of gauze contains 28 threads to the inch in one direction and 24 in the other. The **split pad** is made of about 6 layers of gauze, 8 in. square, and split halfway up from one edge, all edges being turned in and sewn. This is used to protect the cecum and the rest of the field while the appendix is being cut away and the base attended to.

The **binder** is made of canton flannel, with a single back piece reaching about to the midaxillary line on each side, and having 4 or 5 tails on each side. Each tail is 4 in. wide and overlaps the next one 1 in. They should be long enough to reach to the anterior axillary line of the opposite side. A narrow perineal band is sewn to the lower edge, which is passed around the thigh to be pinned again to the lower edge. This prevents the binder and dressing from riding up and exposing the wound.

OPERATIVE METHODS AND CHOICE OF METHODS

ACUTE APPENDICITIS WITHOUT ABSCESS OR PERITONITIS

Preparation of Patient.—Where the appendix is quiescent, the preparation can be more thorough than in an emergency case. The patient should spend the day previous to the operation quietly and on a simple diet, and should drink plenty of water. After a light supper an ounce of castor oil is given. The whole abdomen is shaved and then scrubbed with soap and hot water, using gauze, for at least 5 minutes. The shaving should include all the pubic hair below and to the ensiform level above. A soap poultice follows, made with a solution of castile soap or of tincture of green soap, 1 part to 8 of water. This is left in place all night. A good night's rest is important, and if necessary a mild sedative should be prescribed. If the operation is to be performed early, no food is given in the morning. If after 12 o'clock, a cup of clear broth, tea or coffee may be given at 8. A soapsuds enema, 2 or 3 hours before the operation, is ordered. One hour beforehand the soap poultice is removed, the whole abdomen is gently scrubbed again with soap and water on gauze and then with alcohol, and a sterile compress soaked in 1:5,000 bichlorid is applied. This remains in place until the patient is on the table, when the final scrubbing takes place with soap and water, ether, alcohol and bichlorid. The bladder should be emptied just before leaving for the operating room.

The *iodin method* is preferred by perhaps a majority of surgeons. The abdomen is shaved the night before and a dry sterile dressing applied. When the patient is on the operating table, a dilute tincture of iodin (3 per cent.) is painted over the whole abdomen with gauze on a sponge holder. This is allowed to dry for a few minutes and should then be wiped off with alcohol. If the iodin is left on the skin there is danger of its being carried into the abdomen by the surgeon's hand. Cases have been reported where a plastic peritonitis has been set up, with a resulting ileus. If the iodin is wiped off with alcohol and if the towels are clamped to the edges of the wound before opening the peritoneal cavity this danger will be greatly diminished.

If the operation is performed in an acute attack the preparation must be shorter. The abdomen is shaved and scrubbed as above, a soapsuds enema given and the bladder emptied. If the other method is to be used, the shaving must be done dry, as iodin does not penetrate a wet skin.

Incisions.—The 2 incisions most commonly used are the *intermuscular* and the *rectus*.

THE INTERMUSCULAR INCISION.—A 3-in. incision is made parallel to the fibers of the external oblique. The center of this should be midway between the chief point of tenderness and McBurney's point. Towels are clamped to the wound edges and the incision deepened to and then through the aponeurosis of the external oblique, the latter being cut in the direction of its fibers. After bleeding points have been clamped, the aponeurosis is separated from the internal oblique with the finger for a distance of an inch on each side of the wound, and the edges of the aponeurosis are retracted. The fibers of the internal oblique and transversalis are then separated bluntly for a distance of 2 to 3 in., at first with closed scissors, the splitting being finished with retractors. This line of separation is at almost right angles to the first cut. **Great care should be taken not to cut the branches of the last dorsal or iliohypogastric**

nerves, which can often be seen in the wound. The subsequent weakening of the muscles in the inguinal region has frequently resulted in hernia at that point. These muscle edges being then retracted, the peritoneum is next very carefully lifted up in 2 places with mouse-tooth forceps and a small nick is made with a knife or scissors. Unless the greatest care is used, an underlying loop of intestine on the omentum may be cut, especially if it is adherent to the peritoneum. The peritoneal edges are now seized with artery clamps. This saves time in the closure later on. As soon as the peritoneal cavity is opened, the contents will drop back, and the opening can be enlarged with scissors in both directions. If the omentum protrudes, it must be very gently returned and held out of the way. An empty sponge-holder is useful for this purpose. Sometimes it will be necessary to use a gauze pad. The peritoneal cut may be made parallel to the skin incision or with the line of the inner muscle splitting. If it is found later that more room is needed, the incision may be enlarged at either extremity. At the lower end it may be necessary to extend the cut into the rectus sheath, or to cut across some of the fibers of the internal oblique and transversalis. The muscles may have to be cut above, though often, where a higher exposure is needed, it is better to extend the splitting of the external oblique and then make a new separation of the fibers of the deeper muscles at a higher level. The wound in the peritoneum can later be closed by retracting the bridge of muscle downward and then upward. By this means a large area can be covered through an intermuscular incision.

THE RECTUS INCISION.—The rectus incision is made parallel to the outer margin of the rectus muscle, 1/2 to 3/4 in. mesial to it, its center being opposite a line drawn between the 2 anterosuperior spines. After it has been deepened through the anterior sheath, the rectus muscle is either split or retracted inward. The posterior sheath is then cut through with the peritoneum in the same line as the anterior. One must avoid wounding not only the intestine or omentum but also the deep epigastric vessels. If the latter are liable to be injured in the further manipulation or in the later suture, it is sometimes wiser to divide them immediately between 2 stout ligatures. Usually they can be avoided. Clamps on the peritoneal edges will later prove of value during the stage of closure.

CHOICE OF INCISION.—In the large majority of cases the appendix can be easily reached through either of these 2 incisions. The intermuscular has a decided advantage in the laterocolic and retrocolic appendices and is preferable if a drain is to be left in. The rectus incision gives better access to appendices lying in the pelvis. It also permits of better exploration of other pelvic organs and of the upper abdomen. A firmer wound results in rectus cases when the muscle is pulled to the inner side rather than split, but if drainage is necessary, the latter method gives a more direct course for the tube or cigarette drain.

Locating the Appendix.—If there is any reason to suspect the presence of an abscess, the general cavity must be protected by the insertion of gauze pads. Two

will usually be sufficient, 1 placed to the mesial side of the cecum and 1 below it. The cecum may present as soon as the peritoneal cavity has been opened. If it does not, the finger should be inserted and passed outward, hugging the ventral and then the lateral abdominal wall. This will almost always lead to the cecum, which can be lifted into the wound. By following down the ventral longitudinal band, the base of the appendix is located. If the cecum is not immediately found in this way, the finger should be swept across the iliac fossa until the iliac vessels are felt, and then upward until it is stopped by the mesentery of the terminal ileum. By following this outward, the ileocecal junction will be located at once. Whenever possible, the cecum should be rolled out of the wound and as much as possible of the later work done outside of the abdomen. The non-vascular fold passing from the terminal ileum down to the cecum will often stand out as a convenient landmark. If these 2 methods fail to identify the ileocecal junction, the possibility of non-descent or non-rotation must be considered and search made in the subhepatic or left lower quadrant. The cecum may be found and yet no evidence of the appendix appear to the eye or finger. Careful palpation will then often reveal its position behind the terminal ileum or cecum. Even if it cannot be felt, the cecum should then be mobilized by cutting through the line of the peritoneal reflection along its outer and lower margin. By rolling the cecum inward and upward, the appendix will be found lying in the loose retroperitoneal areolar tissue, or adherent to the dorsal wall of the cecum. When the appendix is found to be retrocecal and erect, it is often safer and easier to divide the appendix immediately at its base, between clamps or ligatures. Both ends should be cauterized and the stump attended to immediately. The appendicular vessels can then be tied off, working distally from the base to the tip, and the organ removed. The position of these vessels, lying mesial to the appendix and dorsal to the cecum and colon and to their vessels (Figs. 25, 26), is the important fact to remember in removing a retrocolic appendix.

Ligation of the Mesentery.—If the mesentery of the appendix lies free, it can usually be tied off with 1 or 2 ligatures. It is best to crush the tissues first with a long clamp, squeezing the fat away from the line of ligature. This clamp is placed so that it is ½ in. away from the appendix distally, and reaches proximally, almost but not quite, to the angle between the base and the cecum, care being taken not to include the intestine. On removing the clamp, a ligature of heavy catgut is passed with an aneurysm needle or some other suitable carrier and tied snugly. The mesentery is then cut at a sufficient distance distal to the ligature to prevent its slipping off. It will often be necessary to ligate the vessels in small sections, each one being cut after it is tied, so as to free the next section to be attacked. This is especially true in the retrocolic type and whenever the appendix is kinked so that the proximal portion of its mesentery remains concealed until the distal part is cut away.

Treatment of Stump.—After the appendix has been freed from its mesentery, the burying or invaginating suture is first inserted. The adjacent field is then protected by a split pad, and the appendix cut off between clamps, removed and the base cauterized.

The 3 methods of treating the stump most commonly used are ligation, burying and invagination.

LIGATION.—Two clamps are firmly placed on the appendix ¼ in. apart, the proximal one being ¼ in. from the base. The latter is removed, and a heavy catgut ligature tied at its former site. The appendix is then cut off between these 2 points and the knife discarded. The stump is carefully held up by the ligature so that the end will not contaminate any of the adjacent structures, and is well cauterized with the actual cautery. A low heat should be used at the end so that the stump is well charred. A second ligature is then tied just proximal to the first in case the former has been weakened by the cautery. This may squeeze out a little of the contents of the appendix, and if so the stump is again touched with the cautery at this point. If the actual cautery is not available, pure carbolic may be used, being applied by a little cotton on the end of a probe or director. It should be followed by alcohol to stop its action.

BURYING.—Before the appendix is cut away, the purse-string suture is inserted. This should be of silk or Pagenstecher thread on a round needle. The needle is first inserted on the side of the bowel toward the assistant, so that he may more easily tie the knot. The suture is made to encircle the base of the appendix at a distance of ⅜ in. In the region of the mesentery the needle must pass under the vessels, so that when the suture is pulled taut, they will be included (Fig. 27). The suture should get a good bite into the muscular coat, but care must be taken to avoid penetrating the lumen of the bowel. The ends are then held loosely by the assistant, and the split pad placed over the rest of the field. The appendix is clamped, ligated, cut away and cauterized as above. The wall of the cecum is next grasped with thumb forceps a short distance beyond the purse-string and held up, the stump is crowded in with small thumb forceps, while the assistant ties the suture. A reinforcing suture of fine catgut on a round curved needle is then inserted, either purse-string, continuous Lembert or Cushing, to further bury the stump. This last suture can be continued on to bring the peritoneum over the stump of the mesentery.

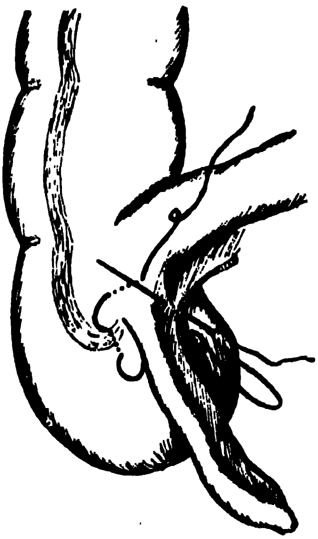

FIG. 27.—INTRODUCTION OF PURSE-STRING SUTURE, NEEDLE PASSING UNDER VESSELS IN MESENTERY.

INVAGINATION.—In invaginating the stump, the purse-string of silk or linen is inserted just as before. A simple purse-string, whose ends do not overlap, is the best suture. A number of other forms of introducing this suture have been devised but most of them are open to the criticism of not always tying snugly. This is more embarrassing when the stump is invaginated than when it is ligated and buried. It is not only annoying to have the purse-string stick and then possibly break before the invaginated base is caught, but the danger from leakage and contamination is a real one and is to be avoided if possible. For this same reason, in introducing the purse-string, the needle should not enter and leave the bowel wall too often. Five or 6 points will be sufficient. The purse-string should not be used for traction while it is still loose lest the intestinal wall be cut through and it be necessary to re-insert the suture. Two clamps are placed on the appendix, and the latter cut between them. The stump is then well cauterized close down to the proximal clamp. The cecum is seized with thumb forceps a little beyond the purse-string suture, the proximal clamp is released, and the stump is invaginated into the cecum by small thumb forceps, while the assistant ties the purse-string.

All the instruments that are used in the stage of treatment of the stump should be discarded after using and the gloves thoroughly washed at the completion of this stage. A small dish on which to place these instruments with the appendix and split pad will be found useful.

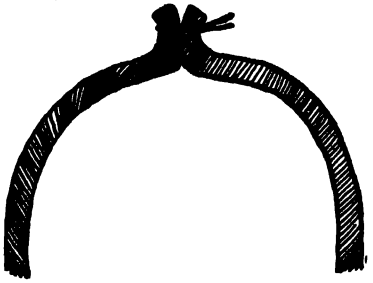

Fig. 28.

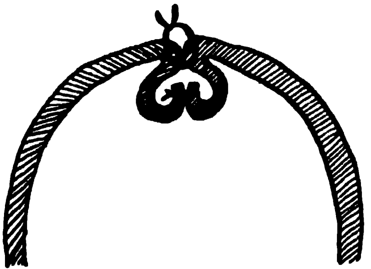

Fig. 29.

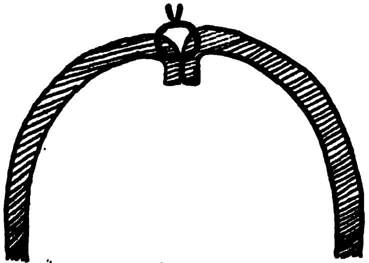

Fig. 30.

Figs. 28–30.—Diagrams Representing Sections through Cecum and Base of Appendix when Latter has been Removed. Fig. 28.—Simple ligation of base. Fig. 29.—Ligation and burying. Fig. 30.—Inversion of stump.

CHOICE OF METHOD.—Simple ligation alone is used by many operators in all cases (Fig. 28). It has the advantage of simplicity and quickness. Where the cecal wall is indurated around the base of the appendix, it may be impossible or unwise to use either of the other 2 methods. It is, however, not as safe as the other methods, for if the ligature should slip off or give way, there is danger of leakage, infection or fistula formation.

Ligation and burying avoid all danger of hemorrhage from the stump and at the same time shut the latter off from the peritoneal cavity, but may occasionally allow the formation of an abscess in this shut off pocket (Fig. 29). Invagination shuts the stump off from the peritoneal cavity and also allows the result of any bleeding or infection to enter the lumen of the bowel (Fig. 30).

The Return of Cecum to the Abdomen.—The stump of the mesentery should be inspected at this point to be sure of good hemostasis. If any raw surface exists, it should be covered with peritoneum. The cecum is then washed off with hot saline and returned to the abdomen. The latter can generally be accomplished by lifting up the retractors which should be still engaged inside the peritoneum. If the cecum be distended with gas this should first be gently squeezed out. (If the stump of the appendix is rigid and hard to invert, a device sometimes employed by the late Charles McBurney may be useful. A fine catgut stitch is passed through the stump and tied. The stitch, grasped in a mosquito clamp, is a powerful persuader toward inversion.—Editor.

Closure.—After making sure that all pads and instruments are accounted for, and that the field is dry, the peritoneum is seized with 2 or 3 clamps on each side and by these held up while its cut edges are sewn with number 2 plain catgut. This may be done with a simple running or a continuous mattress stitch. With the latter the needle is inserted at right angles to the cut edges in an alternating direction. This everts the edges and gives a little greater apposition of peritoneal surface, but takes a little longer to insert. This suture also lessens the danger of the omentum or intestinal surface becoming adherent to the scar.

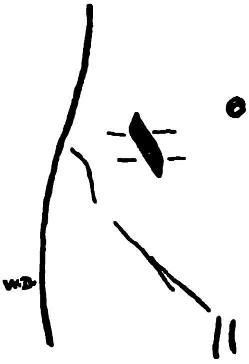

Fig. 31.—Skin Sutures Placed Horizontally to Counteract the Downward Sagging of the Mesial Edge of the Wound.

When the serous coat of the appendix is involved in the inflammatory process, it is teeming with bacteria and must be treated as an infective agent. It should be wrapped with gauze as soon as it is freed from its bed. The muscular planes will in all probability have been exposed and after the peritoneum is closed, they should in such cases be well washed out with peroxid and salt solution. This will lessen the danger of intramural abscess. Two or 3 interrupted catgut sutures will be sufficient to bring the deep muscle together. Care must be taken to reach the transversalis muscle, which retracts more than the internal oblique, and may need an individual suture line. These muscle sutures should not be tied tightly enough to choke the included fibers. If it has been necessary to cut across the fibers of the deeper muscles, the cut edges should be brought together with a mattress suture, preferably of chromic catgut. The external oblique is then closed with a continuous suture of plain catgut. Before suturing the skin, it is well to put in one or two silkworm-gut sutures which include the external aponeurosis and skin. These will tend to obliterate any dead space (see Vol. I, Chap. II). For skin closure, silk and horsehair are perhaps the favorite materials, with a variety of different stitches. The two silkworm-gut sutures will often suffice in an intermuscular incision, if they are inserted in a horizontal plane, rather than at right angles to the wound, so as to counteract the tendency of the mesial edge to drag downward (Fig. 31).

Dressing.—A thin gauze pad, wrung out in 1 per cent. formalin, is laid on the wound and over this a folded half yard of gauze, which is held in place with adhesive straps (see Vol. I, Chap. II). A layer of absorbent cotton and a snug binder complete the dressing.

Before applying the binder the skin surface should be thoroughly dried off. To accomplish this, the patient should be lifted by gripping the femoral trochanters, so that the bend will take place mostly at the hips. The sudden lifting of a patient by an energetic orderly or house officer, who seizes him by the loins, brings a marked strain on the ligaments of the lumbar vertebræ, which is apt to be followed by severe backache lasting for days. He is then placed gently on the stretcher, covered with a hot blanket, well wrapped up and carried back to bed.

ACUTE APPENDICITIS WITH ACUTE LOCAL PERITONITIS

The procedure here is the same for the simple removal of the appendix, except that as soon as the peritoneal cavity is opened the fluid, if very turbid, **is removed by a suction apparatus and pads are placed before searching for the appendix. During the early hours of peritoneal inflammation, the fluid is made up largely of serum rich in antibodies and leukocytes. They represent the attempt the body is making to resist the invading enemy. By removing this fluid we decrease the local resistance and do more harm than good.** As the process advances and the fluid becomes turbid from the presence of dead body cells and both dead and living bacteria, we probably relieve the peritoneum by removing as much fluid as possible, providing it can be done without undue trauma. Excessive sponging does more harm than good, **but a properly protected suction apparatus does very little damage and wastes but little time.**

After the appendix has been removed and the base attended to, the pelvis and right laterocolic gutter should be explored to make sure no collection of fluid exists in either place. If the amount of fluid is small and the visceral peritoneum is only slightly congested, the wound may be closed without drainage. But if the fluid is getting turbid and especially if the peritoneum looks raw and has lost its shiny appearance, a drain should be inserted. This may be removed at the end of from 24 to 48 hours if the drainage is slight, with practically no delay in the convalescence. If a subsequent peritoneal abscess should form it will point along this tract much more readily than if no drain was inserted. **When in doubt, drain.**

ACUTE APPENDICITIS WITH ABSCESS

The main object in these cases should be to bring the patient safely through the present attack. To accomplish this, the primary indication is to drain the abscess cavity. Removal of the appendix is desirable if it can be easily and safely accomplished, but it is often wiser to leave it behind. A careful and thorough physical examination, including a rectal examination, should always be made, in order to determine beforehand, as far as possible, the exact extent and distribution of the process. An abscess at the site of the appendix may be but the primary focus with extension to the pelvis, across to the left side, in the laterocolic gutter, up to the subphrenic region, or with retroperitoneal collections behind the cecum or colon, and much valuable evidence as to the existence of such extensions can be obtained before the patient is anesthetized. If possible, free drainage should be furnished to all existing collections of pus. The incision should be a generous one and so placed as to open first of all the free peritoneal cavity. The important question of whether this is involved or not can thus be answered early, and with less danger of spreading the infection. At the same time the general extent of the process can be determined and the existence of pelvic or laterocolic extensions discovered. The general cavity is then protected with gauze pads and the abscess attacked. If the omentum overlies the mass, embarrassing hemorrhage may result from omental vessels torn in going directly through. For this reason the approach should be from the lateral aspect. By passing the finger gently around between the omentum and the parietes, a line of cleavage will be found opening into the abscess.

As soon as pus is encountered, the suction tip is introduced and the contents evacuated. If this is not at hand the pus must be removed by very gentle and careful sponging. (Open the abscess carefully by a small opening, so that the pus may be taken up by sponges as fast as it escapes, i. e., if no suction device is at hand.—Editor.) Further procedures will vary with the duration of the process. During the first few days the adhesions between the adjacent peritoneal surfaces are still soft and fibrinous, and can be gently separated without bleeding. With such conditions, it is safe and wise to locate and remove the appendix, if the patient's general condition warrants spending the additional time. But after 3 or 4 days these adhesions become more dense and vascular, so that as they are separated they not only bleed but offer free opportunities for further absorption. If the appendix presents and can be quickly and easily removed, it should be, otherwise it is safer to leave it behind, either to slough out later or possibly be removed at a later operation. If any further pockets of pus exist, their presence must be determined and full drainage afforded. It will often be wiser to insure dependent drainage by additional incisions, a stab wound in the loin for laterocolic or retrocolic collections or a posterior colpotomy for a pelvic extension in women. If there be more than 1 pocket, each must receive a drain of its own, which should reach well to the bottom of the cavity. The wound is then closed around the drains without washing out the cavity. Irrigation is too apt to lead to further spreading of the infection. (For many years at the New York Hospital, we have abandoned irrigation and use suction alone. Editor.)

ACUTE APPENDICITIS WITH ACUTE DIFFUSE PERITONITIS

The indications in this group are to afford proper drainage and remove the appendix with as little trauma and as quickly as possible. Any unnecessary prolongation of the operation will lessen materially the patient's chances of recovery. As soon as the peritoneum is opened, the fluid is removed with the suction apparatus and the appendix located. The latter can often be done while the suction tip is still in place. After removing the appendix, it is often better simply to ligate and cauterize the base, omitting the invaginating or burying, even when the cecum is not infiltrated, simply to save that much time. A drain to the bottom of the pelvis, leading by the appendix stump, is inserted, and the wound closed as rapidly as possible. The coils of intestine should be handled as little as possible, as the shock from this procedure and from exposure to the air will add greatly to the risk of the operation. **The partial eventration with painstaking peritoneal toilet formerly practiced was one of the main causes of the early high mortality in these cases.** Extensive washing of the peritoneal cavity with a double current tube or by other methods is still practiced by some surgeons. The gain, however, is probably outbalanced by the bad effects of the added time and trauma. A quart or 2 of hot saline, either poured into the wound or allowed to run in through the drain while the wound is being closed, will often act as a valuable stimulant to tide over a patient who needs the fluid. This should only be done after the major portion of the peritonitic fluid has been removed. When the patient's condition is very critical, it is unwise to prolong the search for the appendix beyond a few minutes. Simple drainage will offer better hope than too long an operation. The shorter and gentler the operation in these cases the greater the chance for recovery.

ACUTE APPENDICITIS WITH PROGRESSIVE FIBRINOPURULENT PERITONITIS

With this very fatal type of peritonitis, there is little hope of success. Here again most valuable evidence can be obtained by a careful physical examination of outlying centers of suppuration before operation. Frequently, however, we will be balked by the mental condition of the patient, if his sensorium is so dulled by the absorption of the products of the disease as to make any localization of tenderness very difficult. The appendix should be removed as quickly as possible and drainage instituted for the adjacent pockets of pus. The raw surfaces bared by strenuous attempts to open further pockets do more harm than good, because of the added absorption. If any of the more widely situated extensions can be located, they should be drained through additional incisions.

(Even in these bad cases, the suction tube, used with great gentleness, insinuated into the several regions where pus pockets are most often formed in these cases, may save life. The following is the routine employed by me. The suction tube is passed first into the pelvis; next, along the outer surface of the ascending colon to the liver; next, straight across the abdomen beneath the omentum to the left flank. Finally, the tube is again passed to the bottom of the pelvis. The abdomen is gently massaged meanwhile.—EDITOR.)

AFTER-TREATMENT

APPENDICITIS WITHOUT ABSCESS OR PERITONITIS

Return from the Operating Room.—During the return from the operating room the patient should be well wrapped up and accompanied by a doctor, or at least a nurse. Accidents such as respiratory obstruction from relaxed tongue muscles, or inspired vomitus have occurred and must be guarded against.

Posture.—The patient is placed on his back in bed, wrapped in warmed blankets, with hot water bags or electric pads NEAR but not touching his feet. The head must be sufficiently extended to insure free respiration and is best turned to one side. A small pillow under the opposite shoulder will aid in maintaining this position. After the patient has recovered from the anesthetic, a low Fowler's position will be found more comfortable than the full supine. This is best obtained by a **Gatch bed,** which allows the head half of the mattress to be tilted upward, while the lower half is angled forward at the knee level. The same posture can also be obtained by a back rest or pillows beneath the shoulders and some support under the knees. The extreme lumbar lordosis associated with the supine position is thus avoided and the whole body is relaxed. This hyperlordosis may be one of the causes of postoperative backache.

The attempt to get patients on their feet after a few days has not proved successful, and the more conservative surgeons do not allow their simple appendicectomy cases to sit in a chair until about the seventh to the ninth day. (The ninth day to get out of bed.—EDITOR.) A single half hour is sufficient for the first day and 2 1-hour intervals the second. After that a few steps are tried, and walking gradually increased until at the end of the second week the patient is usually able to leave the hospital. The after-treatment should not cease at this point. The tendency then is to bid the patient farewell, telling him to take good care of himself for a while. He is apt to follow the advice for a week or so, then take up his full daily routine with perhaps almost full vigor. But he soon finds that he tires easily, concentration is poor and general efficiency is well below par. Often it is 6 months or a year before he really recovers his full working capacity. After any abdominal operation it should be at least 4 weeks, and better 6, before patients begin their normal daily routine whether it be the cares of housekeeping, social requirements, or business. The return to work should be gradual with shortened hours at first and as complete a rest between work hours as possible. Simple diet and early bedtime, exercise moderate both as to quality and quantity, and regulation of the bowels are indicated. Women should be urged to partially undress and lie down without a book, for at least an hour after lunch, not only when convenient, but every day. It is better if they sleep, but this is not necessary. They should be urged to stop before they get tired. The direction of the after-care of these patients is quite as important a part of the treatment as removing the stitches. The complete return to normal is not accomplished at the end of 2 weeks nor of 6. Three months is early and it is more often 6.

Sedatives.—The necessity for sedatives will vary according to the individual. Some patients will be able to go through the whole period without any drug. If this can be done without too much suffering, it will shorten the period of discomfort and is always to be hoped for. It can be more frequently attained if the patient is warned ahead of time that a certain amount of pain and discomfort must be expected, and that it is nothing alarming. A grain of codein phosphate hypodermatically may be sufficient, and this can be safely repeated after 3 hours. When the restlessness or pain is extreme, morphin may be necessary and should be given in full ¼-gr. doses when needed. Another indication for morphin is when the attack has been preceded or accompanied by diarrhea and the excessive peristalsis needs quieting. When the patient is of a nervous and apprehensive nature, great benefit will be obtained from 2 or 3 20-gr. doses of sodium bromid given at 3-hour intervals before the operation, and followed soon afterward by a dram of the same drug by rectum. If the latter is given in 4 oz. of water at 110° F. it will be well retained. This can be repeated every 6 to 8 hours in 30-gr. doses for the first 24 to 36 hours, with excellent results.

Feeding.—Water should not be started until 6 hours after the last vomiting, and then in dram doses, either hot or cold, every 15 minutes, gradually increasing the amounts and intervals. In starting broths, albumen water, tea, coffee, kumyss, etc., one should be guided somewhat by the patient's desire and the amount of persistence of the nausea. They are usually ready for these during the second or third 12 hours. It is wiser not to begin on "soft diet" until the bowels have moved. Then custard, junket, toast, boiled or poached eggs, milk toast and cereals can be used until the fourth or fifth day, when a general light, simple diet may be ordered.

Bowels.—The happiest solution of this problem is to have the bowels move spontaneously on the second or third day. With no distention or absorption symptoms, we may wait even until the fourth day. A small soapsuds enema may then be all that is necessary. The condition of the intestinal tract at the time of the operation must be considered; whether it was rather empty as a result of diarrhea or cathartics previously taken; or whether it was well loaded; whether the patient had been on a very restricted diet for a while, or whether he had been eating a normal or excessive amount. A mild laxative pill at night or a morning saline are indicated if the simple enema is insufficient. When there is a loaded intestine, with coated tongue and other absorption symptoms, or where there are considerable fermentation and gas formation, with no return of the appetite, a full dose of calomel will be of great assistance. Ten 1/10-gr. doses or 6 quarter grains should be given at 15- to 30-minute intervals and followed in 2 hours by a saline. (I wait 6 to 8 hours.—EDITOR.) If there is no result 2 or 3 hours later a soapsuds enema is indicated. Four to 6 drams of castor oil may be preferred to the calomel and saline. After the bowels have been once well started, a mild nightly pill or a morning saline will usually suffice if anything at all is needed. It is much better to give a small dose every day than a more aggressive treatment every 3 or 4 days. The intestinal paresis following the exposure and manipulation at the time of operation usually subsides after 12 to 24 hours. The resumption of peristalsis is irregular at first, so that the various segments are not acting in unison. This is very likely to be accompanied by colicky pains, which may be quite severe and are usually described as "gas pains." They may be alleviated by the local application of heat, by enemata or hot saline irrigations. The taking of food will often help to regulate and systematize this faulty peristalsis. When it is accompanied by distention and tends to become more pronounced, the possibility of mechanical ileus must be recognized.

Dressings.—If the temperature is normal and there is no abnormal tenderness in the wound, the primary dressing may be left in place for 5 to 7 days. The stitches are then removed, and the wound may be reinforced by small strips of adhesive plaster which have been first passed over an alcohol flame. Touching each stitch hole with a little tincture of iodin, before pulling through the silk or other suture material, is a little extra precaution against stitch infection. The abdominal binder may be discarded after the tenth day, unless the incision has been unusually large or the muscle fibers have been cut across, when it is indicated for 3 weeks.

APPENDICITIS WITH LOCALIZED ABSCESS

These patients should *remain in bed* until the wound healing has reached the level of the external oblique. An exception to this can be made if a small sinus with slight discharge persists for some weeks, when the patient may be allowed up and about as soon as all other local symptoms have disappeared. The *dressings* should be changed on the second day after the operation, and frequently enough after that to prevent any backing up of the discharge. When the latter is copious, this may be necessary 2 to 3 times a day for a while. Irrigations with hot saline solution will aid in getting rid of the heavier necrotic particles or the more tenacious pus. Great care must be observed to see that free exit for the solution is allowed and that a gentle stream is used. The irrigating jar should not be held more than 8 to 12 in. above the wound level. Drains are to be shortened gradually and removed only when the amount of discharge warrants it. The custom of blowing out the cavity with dilute peroxid should only be permitted when there is a large drainage tube, and after the abscess cavity is well walled off from the general peritoneum. **The force of the bubbling gas is sufficient, if restrained, to break down the softer adhesions and allow an extension of the process. For this reason also the syringe should be quickly withdrawn from the end of the tube.** (Peroxid irrigations I regard as dangerous in these cases.—**Editor.**

APPENDICITIS WITH SPREADING PERITONITIS

Posture.—Fowler's position is of the utmost importance in these cases and will add greatly to their comfort, as well as the more important tendency to localize the inflammatory process. (More important for the easier expulsion of stomach gas than for any other reason.—Editor.)

Rest for the Inflamed Peritoneal Surfaces.—Rest for the inflamed peritoneal surfaces is indicated, and this is best obtained by stopping peristalsis. Morphin hypodermically and an empty stomach are the 2 most efficacious means. Lavage should be repeated as long as there is any vomiting or any tendency for the stomach to fill up from below. The body craves fluid and it must be supplied, but it will not be absorbed from a vomiting stomach. A large quantity of salt solution, however, will be absorbed from the large bowel. The 3 ways of supplying this are by the continuous drip, 6- or 8-oz. enemata, and rectal irrigations. All 3 are useful, either alone or used alternately. More fluid will be absorbed from the first method if it is retained, and this depends very largely on attention to details. A firm tip should be used, just long enough to pass well by the sphincter and so arranged as to lie comfortably in the anal canal without pressure. The container should be low enough so that any increase in intra-abdominal pressure, such as from cough, hiccough, or straining, can force the fluid back inside the tube. The latter 2 methods should be employed at 4-hour intervals. In addition to the rectal route, it may be necessary to give the salt solution subcutaneously or intravenously. The administration of sufficient salt solution is the most important part of the after-treatment of peritonitis, and too much personal attention cannot be paid to it.

DANGERS AND DIFFICULTIES

Hematoma of Wall.—Unless all bleeding points are carefully ligated, hematomata may follow. In the subcutaneous tissue these are of little importance and, if promptly evacuated, will not delay the convalescence. If they occur in the muscles and are of large size, they may materially delay firm healing. Small uninfected hematomata are absorbed in a few weeks and need not be disturbed, but the larger ones must be opened, the clot evacuated, and the cavity packed. The hematoma may become infected; if this occurs, it should be opened and drained as soon as recognized.

Hernia.—Hernia following appendicectomy may result from 2 causes, prolonged drainage or nerve injury. Where a drain has been used for a long period, the wound may heal without approximation of the muscle edges, so that a weak spot is left at the former site of the drain. The abdominal wall may later on give way at this point and allow the protrusion of abdominal contents. The branches of the twelfth dorsal and ileohypogastric nerves are very likely to be wounded in making an intermuscular incision, unless the deep muscles are split and separated with blunt dissection. This sometimes results in a weakness of the abdominal wall below and mesial to the scar, which may lead to the formation of ventral or inguinal hernia.

Muscle Atrophy.—In splitting the rectus or pulling it to one side, sufficient nerve branches may be divided to result in atrophy of the portion of the muscle which lies to the mesial side of the scar.

Wounds of the Omentum or Intestine.—Wounds of the omentum or intestine made in entering the peritoneum can generally be avoided by lifting the latter up between thumb forceps. When these structures are adherent, however, injury is sometimes unavoidable. Such a wound should be immediately repaired, in the omentum by ligation and in the intestine by catgut suture if only the serous and muscular coats are injured, and by a double layer of suture if the mucous membrane is wounded.

Hemorrhage from the Mesentery.—When the mesentery of the appendix is clamped, cut, and ligated in sections, one of the cut vessels may slip back between the leaves of the mesentery and give rise to embarrassing hemorrhage. This is less apt to occur if the ligature is passed and tied before cutting. If it cannot be controlled by a ligature placed proximal to the cut edge, the 2 leaves of the mesentery must be dissected back until the actual bleeding point is found and ligated. Otherwise, a hematoma of embarrassing size may form. In pursuing a bleeding vessel in this region, there is danger of grasping the ureter if a long clamp is used blindly.

Piercing the Mucosa of the Cecum.—The danger of the purse-string suture piercing the mucosa of the cecum is not great if it is inserted carefully. Moreover, if a round needle is used, the consequent leakage is almost negligible, and will be covered by the reinforcing catgut suture.

Leakage from the Stump.—Leakage from the stump, however, is a real source of danger. When the base is invaginated without ligature, after cutting off the appendix and cauterizing the stump, there is occasionally a little leakage of intestinal contents after the proximal clamp is removed and before the stump can be turned in and the purse-string tied. If the field is well protected with a split pad or other suitable means and any soiled instruments discarded, this may not matter. But if the infective material runs down along the cecum into the laterocolic or infracolic or even pelvic regions, it may easily give rise to a subsequent peritoneal abscess. To avoid this occurrence, the proximal clamp should be put on very firmly so as to crush the tissues and the final use of the cautery should be with dull heat so as to well char the stump. This is best obtained by pinching the tube of the cautery bulb and shutting off the air supply till the tip shows no tendency to stick to the charred surface. Distention of the cecum is another factor which should be eliminated before removing the clamp, by squeezing the gas up into the ascending colon, lest the gas under pressure force its way out, separating the cauterized edges of the stump.

Hemorrhage from the Stump.—The posterior branch of the ileocecal artery divides into 2 parts behind the terminal part of the ileum. One becomes the

artery of the appendix and the other passes to the inner wall of the cecum. The anastomosis between these 2 is slight, as is shown by the small amount of bleeding from the appendix after its mesentery is tied off and cut. In spite of this fact, cases are occasionally reported where extensive and even dangerous hemorrhage has occurred from the stump of the appendix. This may occur into the peritoneal cavity or, when the stump is invaginated, into the lumen of the cecum. To guard against this when the stump is invaginated, it is necessary to use considerable force in applying the proximal clamp, so as to crush the tissues, and also to see that the purse-string suture dips under the vessels at the mesenteric angle (Fig. 27). The use of the final dull heat of the cautery also tends to avoid this accident. If the appendix is ligated carefully and not cut off too near the ligature, this will not occur. In the severe gangrenous type, with involvement of the adjacent cecum, hemorrhage may occur later from necrosis of the wall of the cecum.

Adhesions.—Adhesions may offer difficulties of considerable severity. They are of 2 varieties—the old, firm adhesions, which are either developmental or the result of previous inflammations, and the recent fresh adhesions. By anchoring the cecum and appendix to the background of the abdomen or pelvis, they interfere with the easy delivery of the bowel into or out of the wound. With the old adhesions to the parietes, the peritoneal reflection can be cut and separation made bluntly with finger or a gauze sponge on a holder, almost with impunity, if the course of the mesenteric vessels is kept in mind so that they are not torn. The adhesions themselves are practically non-vascular. Similar adhesions to adjacent loops of bowel, however, must be separated with the greatest care lest the intestinal wall be injured. Fresh inflammatory adhesions present 2 stages, which must be handled quite differently. In the first few days of an acute inflammation the appendix or loops of bowel will adhere to adjacent structures because of the fibrinous exudate on their peritoneal surface. These may be gently separated with the finger without fear. After the first 3 or 4 days, however, they become firmer and more vascular, so that as they are torn apart a raw bleeding surface is left. Such a surface will not only re-form adhesions with whatever it comes in contact, but offers a new area for absorption of the products of the existing infection. At the same time the adjacent areas of the peritoneal cavity and its contents are also exposed to the spreading of the inflammatory process. Such adhesions must be treated with the greatest respect and only disturbed when absolutely necessary.

Injury to the Ureter.—The ureter has occasionally been injured during an appendicectomy. It may be caught in a clamp or included in a carelessly placed deep ligature.

Injury to the Ileum or Cecum.—The terminal ileum or cecum may be penetrated in passing a ligature through the mesentery unless care is taken to look at both sides of the latter as it is passed.

CAUSES OF FAILURE

Most surgeons have had to admit at one time or another that they were unable to find the appendix. True absence of the appendix has been noted in a few rare instances, either at autopsy or in the dissecting room, on bodies which showed no scar in this region. Usually the failure to locate the appendix by the surgeon is due to its abnormal position or to its being so hidden by adhesions as to make its detection most difficult. This failure can often be avoided if, after proving its absence from the ordinary positions, the operator will mobilize the cecum by dividing its lateral peritoneal reflection and rolling it mesially so as to expose its dorsal surface.

The surgeon may well fail to remove the appendix when a persistence in the attempt will endanger the patient's life. With an old abscess cavity, walled off by firm adhesions whose separation would mean the opening up of new areas of infection and absorption, or with a patient whose general condition will permit only the briefest of operations, the surgeon must often be satisfied with the simple establishment of drainage.

COMPLICATIONS

Infection of the Operative Wound.—Infection of the operative wound is not uncommon after the removal of an acutely inflamed appendix. The peritoneal surface of the latter is teeming with bacteria, and if it is brought in contact with the sides of the wound, they are quite likely to be contaminated. This danger can be lessened by keeping the appendix wrapped in gauze after its mesentery is cut, or earlier if possible, and by careful washing of the separated muscles after the peritoneum is closed. When an abscess has formed, it will be shown by the presence of a tender mass under the scar, accompanied by a little elevation of temperature and pulse-rate and an increase in the number of leukocytes and percentage of polymorphonuclears. If such a condition is left unnoticed, it undoubtedly predisposes to thrombosis. Therefore, any delay in the return of the temperature to normal calls for an inspection of the wound, and if the latter looks at all suspicious, a probe or grooved director should be inserted. When pus is found, the wound should be opened widely as soon as the fact is recognized, the contents well evacuated, and the cavity packed with gauze. The application of tincture of iodin to the abscess cavity will hasten healing to a marked degree. This should not be used, however, if there is any chance of its getting into the peritoneal cavity, where it would set up an adhesive peritonitis. If the process clears up in a few days, it need not delay the convalescence. If the process penetrates to the deep layers, it may weaken the scar sufficiently to predispose to ventral hernia.

Peritoneal Abscess.—A subsequent peritoneal abscess may develop at any time after the operation, but rarely after 16 days. A little leakage from the stump may run down into one of the dependent portions of the peritoneal cavity and give rise to a slow forming process which is localized by adhesions of the adjacent coils, to be recognized later by a little rise in temperature, pulse-rate, and blood count with deep tenderness. The latter may be elicited on rectal examination. This condition may follow the use of too shallow a drain or its premature removal, or a deeply situated collection may not have been recognized and drained at the time of the operation. The most frequent sites for such conditions are in the pelvis, the subcecal fossa, and the laterocolic gutter; more rarely they are found to be subphrenic or in the left iliac region. Such a process will often be self-limited and may be absorbed. When it is situated deep in the pelvis and the symptoms are subsiding, delay is justifiable, as the risk of soiling the general cavity in opening and draining the abscess must be taken into account. If it does not subside, drainage must be instituted with as little trauma as possible, either through the old incision or by a fresh one directly over the lesion.

Fecal Fistula.—Fecal fistula has become an infrequent complication, owing to better technic. It is occasionally seen when the gangrenous process has extended beyond the base of the appendix to the adjacent wall of the cecum. Pressure from too rigid rubber drainage tubes may lead to necrosis of the intestinal wall. In the large majority of instances they will close spontaneously within a week or 10 days. Occasionally they persist for a longer period and may need a secondary operation, with excision of the fistulous tract and closure of the opening in the bowel. The latter should be reinforced with 2 or 3 additional layers of Lembert sutures or by an omental patch. While the fistula is running, the skin should be carefully protected from the discharge. When the discharge is profuse, this is best done by some form of suction drainage, either by a filter pump or 2-bottle syphon method. After the discharge has decreased to a small daily amount, a bland ointment, preferably made up in lanolin, will be sufficient to protect the skin.

Ileus.—Ileus is one of the complications most to be feared. It may be adynamic or mechanical. The *adynamic* or *paralytic form* is liable to be brought on by excessive handling and exposure to air of the intestines at operation. It is often associated with a progressing peritonitis. A severe type is met with in mesenteric thrombosis. The distention is progressive and becomes marked. There are less colicky pain, nausea, and vomiting than with the mechanical form, but these symptoms do occur. No feces or gas is passed by rectum even after enemata or irrigations, except what is already in the lower colon.

The *mechanical form* is due to adhesions which kink a coil of intestine, bands compressing the bowel, or volvulus of a coil. The pressure of a drainage tube may be sufficient to compress the bowel. A loop of intestine may become caught in a hernial opening or in one of the peritoneal fossæ. The symptoms are more marked than the dynamic form, though the diagnosis is often most difficult to make. The pain is more colicky, corresponding with the peristaltic attempts to overcome the obstruction, and is often associated with visible peristalsis. The distention appears early and is progressive, varying in character with the site of the obstruction. The *adynamic form* can usually be relieved by non-operative measures. Simple soapsuds enemata, followed by colon irrigations of hot saline solution, enemata of alum water (2 drams of powdered alum to a pint of water), or ox gall (half ounce to the pint), or turpentine (2 drams to the pint) are often effectual. Hot turpentine stupes to the whole abdomen changed frequently for 20 minutes may be repeated every 3 or 4 hours. The hypodermic use of atropin sulphate or of eserin in 1/60-gr. doses can be repeated every 2 or 3 hours until general effects are noted. Recently pituitary extract has given excellent results in a few cases.

For the *mechanical form* of ileus, celiotomy and relief of the obstruction are necessary. If the distention is extreme, an ileostomy or colostomy is sometimes indicated. A certain amount of intestinal stasis is the rule after any abdominal operation, but it should not last much more than 24 hours. After this the diagnosis between the paralytic and mechanical ileus is most important and most difficult. In order to be successful the operation must be performed early. In either form it is of greatest importance for the patient to get as much salt solution as he possibly can, both by rectum and subcutaneously.

Thrombosis.—Thrombosis following appendicectomy is seen most frequently in the femoral vein, usually the left. There is pain, dull and heavy in character, in the affected thigh with tenderness over the course of the affected vein. There may be some edema of the extremity with slight local cyanosis. It may appear at any time up to 3 or even 4 weeks after the operation. The patient should be kept flat in bed with application of heat or cold to the affected region. A snug bandage over cotton will add comfort. Complete rest will greatly lessen the danger of embolism.

Mesenteric Thrombosis.—Mesenteric thrombosis is an uncommon sequela. The onset is sudden and marked with severe abdominal pain, nausea, vomiting, and considerable prostration. These are soon followed by the picture of acute ileus. Where a small area of the intestine is affected, an early partial enterectomy may be successful, but the prognosis is well-nigh hopeless.

Pylephlebitis.—Pylephlebitis is usually fatal when it follows appendicitis. It is more apt to develop where the mesentery of the appendix is thrombosed, thick and edematous, or where the appendix has ruptured into the mesentery and an abscess has developed between the 2 peritoneal layers. It is characterized by a very irregular temperature, with repeated chills and high pulse-rate. Later, a tender, enlarged liver can be made out and jaundice appears. Operation is contra-indicated and nothing can be done beyond easing the patient.

Pulmonary Thrombosis.—Pulmonary thrombosis is ushered in with severe pain referred to the portion of lung affected, often with chilly sensations and a rise in temperature with increase in rate of pulse and respirations. If the area involved is sufficiently large and near the surface, definite physical signs can be made out. The prognosis is usually good, unless a very large portion of the lung is affected.

Pneumonia.—Pneumonia following appendicitis is not at all uncommon. It usually runs a rather mild course, with an early resolution by lysis. The outcome is favorable in the large majority of cases.

RESULTS

The mortality after appendicectomy will vary greatly. Among the determining factors are the duration and severity of the disease, the existence of complicating peritonitis, abscess or retroperitoneal cellulitis, the skill and care of the operator, and the general condition of the patient.

In a large series of cases collected by Coffey the gross mortality was 7.4 per cent. But if operation is performed early in the disease, it should be below 2 per cent. Many surgeons have had 100 consecutive cases without a fatality. When a spreading peritonitis exists at the time of operation, the mortality will be between 5 and 10 per cent., even with the most ideal care.

The end results, when the patient recovers after the operation for acute appendicitis, are very satisfactory. An improvement in general health is the rule, and it has but few exceptions. Occasionally they will complain of more or less persistent pain referred to the cecal region, which is usually due to adhesions. These may lead to ileus and require further operative intervention. The mortality after interval operations should be less than 1 per cent.

The cure after an operation for chronic appendicitis will depend largely on the correctness of the diagnosis and the coexistence of other lesions, such as right upper quadrant disease or renal stone. The relief from symptoms of "intestinal indigestion" is almost always most marked after a few months if not immediately.

CHAPTER X

OPERATIONS ON THE PERITONEUM

FRANK S. MATHEWS

ACUTE PERITONITIS

The results of the treatment of this serious disease have marvelously improved within the last 10 to 15 years. The improvement redounds to the credit of both physicians and surgeons—to the physicians because the cases are more early referred to the surgeons for operation. The points in treatment which seem to be of the greatest importance are:

1. Prompt diagnosis.
2. Operation before the complete development of the symptom-complex which we now associate with the terminal stages of the disease.
3. Short operation in bad cases.
4. Restricting operation to essentials, which usually means removal of an infecting focus, such as an appendix or a gall-bladder or a closure of a leak in a hollow viscus.
5. Better understanding of drainage principles.
6. Abandonment of cathartics before and after operation.
7. Administration of fluid by other than the stomach route.

Peritonitis is usually a secondary disease. When it is primary or idiopathic, it is usually terminal and hence hopeless. The infection enters through wounds which may be accidental or surgical, but vastly more often does it follow an infection of one of the hollow viscera, the normal or abnormal flora gaining entrance to the peritoneum either by means of an inflammatory or traumatic lesion of the viscus. Irritant solids or fluids (gastric or pancreatic juice, bile, urine, feces, etc.) may complicate the picture. Gastric and pancreatic juices will produce a profound shock on which the peritonitic symptoms are grafted as soon as the bacteria do their work.

Little will be said in this chapter of treatment based on bacteriology, because we rarely know the bacteria or their virulence until treatment has been well established. No doubt prognosis is much modified by bacteriology, but it is only in special cases that the time of operation or the kind of operation will depend on bacteriology. The gonococcus and pneumococcus varieties will occur to the reader as exceptions in some degree to this statement.

The peritoneum is an actively secreting and absorbing surface whose area is about that of the skin surface of the body. Foreign particles and fluids absorbed from it appear in mediastinal nodes or blood stream in a surprisingly short time, and this absorption goes on largely independent of changes in the body's posture. When the peritoneum is subjected to a chemical or mechanical irritation, we may distinguish 2 effects. First, there is a rapid secretion of fluid at first with few, later with many, leukocytes; second, there is a formation of fibrin, which isolates the irritant from the remainder of the peritoneal cavity. The exuded fluid either makes its escape through a wound if one is present or is absorbed by other portions of the peritoneum, such as the diaphragmatic. But the second process which glues together the peritoneal surfaces is soon complete, and nature's task of isolating the irritant from the peritoneum is accomplished. If there is a wound, drainage may continue but in diminished amount and comes from the walls of the drainage tract and not from the peritoneum. If peritoneal secretion continues, it must then be taken care of as it was before the peritoneum was opened, by absorption through lymphatics and blood-vessels.

One fact is established. There can be no method of permanently draining the peritoneum on to the skin surface of the body. Such drainage can be continued no longer than is necessary for nature to isolate a portion of the peritoneum from the remainder. In view of experimental and clinical evidence, a question, then, that we ask ourselves in treating widespread peritonitis should be: Will drainage for the few hours during which it is possible be a material aid in treating the peritonitis? We are not, of course, speaking now of the drainage of an intraperitoneal abscess or the quarantining of a suppurating viscus from the peritoneal cavity.

It is difficult to arrive at conclusions regarding methods of treatment by comparing different operators' statistics, because there is every gradation between the mildest and most severe peritoneal inflammation, and no clinical criterion separates cases into discrete classes, but they grade insensibly into each other. Further, with the short incision and rapid removal of a focus, we are unable to state in a given case just how extensive the peritoneal infection is. The exudate may be everywhere, yet the injected peritoneum, with dulling of its normal glistening surface, may be limited to a small area. Terms such as general, diffuse and spreading, as applied to peritonitis, are used with variable meaning. Cases are even included under these headings in which cultures from the exudate prove negative.

A stage may arrive in peritonitis in which no treatment can avail, and the decision as to what cases are to be included in this group and whether these cases are to be excluded from our operation lists modifies our statistics accordingly. A surgeon who operates in several hospitals may be able to observe differences in the average severity of his cases in the different institutions.

We should aim to prevent rather than cure, and here the field is large. Early treatment of gall-bladder, appendix, and gastric ulcer will prevent many cases of peritonitis. If we could know which typhoid ulcers will perforate, the time to operate would be before the perforation takes place.

THE NON-OPERATIVE AND PRE-OPERATIVE TREATMENT

There can be no doubt that peritonitis of some kinds subsides with little or no treatment. The dense adhesions that we frequently see about various organs testify to the fact. In some of these cases the bacteria have been confined to the inflamed viscus so that the peritonitis must be thought of as due to the toxins of bacteria rather than to the germs themselves. Then there is the peritonitis which leads to localized abscess which may succeed in discharging into a hollow viscus, or even externally, and finally there are diffuse and general types of inflammation.

To recommend a different treatment for the different grades of inflammation and to apply it properly would presuppose a clinical ability to recognize the various forms and differentiate them accurately. This we can do in many cases with scarcely approximate accuracy. Some would say "when in doubt operate," as it is better to make the mistake of operating on some cases that might recover without it than to allow our conservatism to withhold operation until a time when operation is without avail. It is not wise, however, to let our judgment, which should grow with experience, be dethroned by any such simple formula. Each case must be judged on its merits both as to whether and when to operate.

Practically, however, we find that the criterion which guides us in determining the question of operation more than anything else is our clinical experience with inflammations of each particular organ.

Experience has shown that gangrene with rupture of the appendix and a resulting abscess or diffuse peritonitis is so common in inflammations of this small organ that the part of wisdom is to anticipate trouble by removing the appendix before serious peritoneal complications arise, and the decision is made easier by the known uselessness of the appendix. The Fallopian tube, however, in its inflammations behaves quite differently and we usually apply the non-operative treatment, even in acute cases. If the salpingitis is gonorrheal (and it is rarely a mixed infection) we are safe in assuming that the peritoneal inflammation will localize the tubal one and not result in general peritonitis and death. The distended tube rarely ruptures from traumatism, and a gangrene, which is an every-day occurrence in the appendix, is quite unusual in the Fallopian tube. There are other bacteria whose behavior in the pelvis is quite different. The puerperal pyogenic infections are among the most serious, but even here conservatism is the usual course to pursue. The milder ones disappear spontaneously and the more severe are not benefited by radical surgery. A hysterectomy often does not check the bacterial invasion, even when it does not itself kill the patient, as it often does. Puerperal infections may run their course without any peritonitis, even the fatal ones. If, however, the infection does spread to the peritoneum, operation may be necessary but at the same time may have to be incomplete, that is, fail to remove the focus in the uterus or tube. Operation then has for its aim the closing off of the process from the free peritoneum, leaving the patient still to contend with a suppurative process in tubes or uterus.

The gall-bladder occupies an intermediate position between the appendix and uterotubal processes. Its attacks of inflammation frequently subside, leaving thickenings and adhesions. On the other hand, they may give rise to perforations and diffuse peritonitis.

Acute ruptures of stomach and intestines, including typhoid, call for immediate operation. Whatever may be said of inflammations of viscera while the inflammation is confined to the viscus, we believe that the great majority of surgeons would always advise operation in diffuse peritonitis, unless the patient is in extremis. Waiting for a spreading peritonitis to wall off and form an abscess is a dangerous procedure, particularly so in the hands of the inexperienced, who most often resort to it. However, we must recognize that there is a useful field and a fairly large one for non-operative treatment, first, in the types that may be reasonably expected to be local, second, when consent for operation is refused, third, when other serious conditions make operation unusually hazardous, and fourth, while operation is being arranged for.

The modern belief as to the resistance of the peritoneum to infections has greatly changed. A few years ago nothing seemed more serious than the exposure of the peritoneum. Now we look upon this membrane as having greater bactericidal activities than other tissues. Thus we often spill pus in the cavity in the course of a pelvic operation, remove it with sponges and close the abdomen without drainage, with the frequent result that the peritoneum takes care of the infection, but a suppuration is started in the abdominal wall.

Opium Treatment.—Before the days of laparotomies the opium treatment was the accepted one for peritonitis. It had one very good effect, its action immediately stilled the peristalsis in that great spreader of infection, the small intestine. This is now done in a better way, and the objection to large doses of morphin is obviated. The objection to it is that in the early hours of peritonitis, when there is greatest danger from the wriggling of the small intestine, morphin obscures the symptoms and leads the physician into a fool's paradise. The lessened pain and vomiting are taken as signs of improvement, though the peritonitis may be steadily progressing.

Yates has recently urged the use of opium at the beginning of a peritonitis in these words:

"The administration of sufficient opium to guarantee the requisite freedom from movement is of almost equal [to bodily quiet] importance, notwithstanding the more

or less fancied dangers of masking symptoms or of inducing tympanites. Starvation does not immediately nor does it always completely control peristalsis; and, in addition, intestinal activity provoked by local toxic irritation merits consideration. The value of this means of controlling the diffusion causing the *early, which is the most dangerous,* absorption has not been sufficiently recognized."

Postural Treatment.—Murphy says that posture in peritonitis is of great importance. The head of the bed should be raised as soon as the diagnosis is made. In this regard he makes no distinction as to whether the process is beginning in the upper or lower abdomen, but raises the head in all cases. The position is maintained in transferring the patient to the hospital and operating room. The whole subject of postural drainage is considered under the postoperative treatment of peritonitis.

Cathartic Treatment.—These drugs were used much more in former days than now. The surgical objections to them may be considered under 2 heads:

1. They disseminate a peritonitis. They increase peristalsis, especially of the small intestine, at a time when nature's method is to inhibit it and thereby keep the process confined to the region of the starting point. The danger from this cause varies much, however, with the location of the focus. There may be comparatively little danger from this cause in a low lying tubal inflammation or appendix lying to the right and behind the colon; on the other hand, the danger is great when the inflamed appendix lies among small intestinal coils. The stock answer of the physician who uses cathartics in acute abdominal conditions is that he has seen many cases much improved at once by "a good cleaning out." This is no doubt true, but these are the cases in which the cathartic has operated and in which there probably was no active peritonitis in the region of the peritoneum that would be unfavorably influenced by this peristalsis.

2. The second harm from the use of cathartics is seen in the cases where they have been unable to produce an evacuation. In these cases the symptoms of acute obstruction are added to those of peritonitis, that is, more vomiting and greatly increased abdominal tension. The best illustration of this is seen in appendix cases. The peritonitis with arrested peristalsis may be considered to first affect the lower ileum, so that no fluid can be made to pass that point. Then, as the cathartic causes the intestine above to fill with fluid and to increase its peristalsis, there is no relief but in vomiting. We see too many patients whose symptoms immediately become aggravated following a cathartic to believe that these objections are theoretical. It has seemed to me that nearly, if not all, my fatal appendix cases had been given cathartics. Morphin makes the cathartic treatment worse by lessening or preventing the vomiting that might otherwise promptly rid the stomach of the offending cathartic.

Case: A vigorous man was seized with severe cramps at 6 P. M.; during the evening a diagnosis of appendicitis was made; divided doses of calomel were given in the first half of the night, also morphin for the pain. In the morning, the calomel having failed to work, hourly dram doses of salts were given; more morphin was thought necessary. When seen at 3 P. M., that is, 21 hours from the onset, the abdomen was rigid and greatly distended. There had been very little vomiting until an effort was made to give ether. Fluid then ran from the mouth in an almost continuous stream. It was found impossible to continue the anesthetic. An incision was quickly made, and the appendix, which lay immediately beneath the incision, was removed and drains were inserted. The patient succumbed in another 24 hours. There is little doubt that cathartics killed this patient.

Stomach washing can only partly remove the danger of an anesthetic in such cases, for the stomach fills up as fast as emptied. The danger increases with the relaxation that the anesthetic produces.

The Ochsner Treatment.—This is a non-operative method recommended in the treatment of appendicitis and diffuse peritonitis. The purpose of the treatment is like that of the old opium treatment of peritonitis, to still peristalsis in the small intestine, thus favoring localization of the process. The following is an outline of Ochsner's treatment:

1. Operation is urged in cases seen within 48 hours.
2. No food, water or cathartics are given by mouth. Water may be begun in 24 to 48 hours.
3. Gastric lavage if there is even a tendency to vomiting. Repeat as often as necessary.
4. Water and nourishment are given by rectum at intervals, but never in quantities of more than 3 or 4 oz.
5. No evacuant enemas are given.
6. Avoidance of abdominal massage under the name of examination.

Ochsner's views on this treatment as applied to appendix cases may be illustrated by 3 quotations from his "Handbook of Appendicitis."

"McBurney for instance says, speaking of gangrenous appendicitis, that 'recovery from such an attack without operation is inconceivable' and many other authors are quite as positive on this point. That this theory is not correct, I have demonstrated many times by operating on those patients at various intervals after such an attack, and have shown that during the attack the appendix was indeed gangrenous."

"When I first examined this patient he was in a farm house; there was no trained nurse available, neither were there trained assistants at hand. The patient's temperature was 104° F., his pulse 140; his abdomen was enormously distended; his features pinched and he was delirious. My experience with similar cases had taught me that whenever I operated upon patients in this condition the patients invariably died. . . . I have learned that this case belonged to a class which practically never recovered after operation, if it is done while the condition is that in which I found this patient and of which a large majority recover if the treatment is followed which I have described. In this case the operation demonstrated the fact that the child had indeed suffered from a diffuse peritonitis due to a perforation of the appendix, and still, with this treatment, within two days was practically out of danger and went on to a complete recovery from this acute attack, the only pathological condition remaining being an enterolith in a perforated adherent appendix together with diffuse peritoneal adhesions.

"The nutrient enema of 3 to 4 oz. every 3 to 6 hours will overcome the feeling of hunger to a great extent, and patients will not suffer greatly even if it is necessary to continue the exclusive rectal alimentation for three or four weeks, although it is almost never necessary to continue this treatment so long."

It will be seen from the quotations that Ochsner himself is not restricting the treatment to such appendix cases as are mild in character with the idea of preventing diffuse peritonitis, for he urges operation as much as anyone else in the first 48 hours. But it is distinctly stated that by it we may cure diffuse peritonitis and gangrene of the appendix. Others have extended this treatment to peritonitis of other than appendiceal origin and indeed it would seem to be equally applicable to Fallopian tube or gall-bladder inflammations. The treatment is said by Ochsner not to be applicable to children and old people; to the young because they will not coöperate and stomach washing is too difficult; to the old because they do not tolerate prolonged rest in bed.

Ochsner's plan is probably the best one devised for the non-operative treatment of peritoneal or threatened peritoneal inflammation, as it seems to check peristalsis effectually.

But it seems difficult to believe that there is any stage of a purulent peritonitis in which the patient would not be better off with an external vent for the exudate and with his focus of infection removed, we relieve him of just so much infectious material that the body must otherwise dispose of. Further, there are too many surprises in the peritoneal cavity to make it safe for the practitioner of average attainments to wait, in a diffuse peritonitis, for an improvement that may never come. A vent to the fluid we believe is always an advantage and we consider it safer to operate on any day of the disease, in bad cases, doing the operation as quickly and with as little disturbance of the patient as possible. Should operation, however, be interdicted for any reason or postponed for a few hours, as, for instance, until the surgeon arrives, in peritonitis of any origin, those responsible for the case can scarcely do better than to follow Ochsner's treatment in every detail.

Applications of Heat or Cold to the Abdomen.—These have been in use for a long time, but still the decision as to which to use in a given case or how much good they do is hard to make. An ice-bag in the presence of tenderness and rigidity seems to somewhat anesthetize the parts so that an examination may be more satisfactorily made. Cold is usually agreeable to the patient so long as temperature continues and it at least does no harm. Heat is more agreeable in the subacute or chronic inflammations. Applied to the abdomen, there is some reason to think that it increases peristalsis.

WHEN SHALL WE OPERATE?

1. **When an inflammation is confined to a viscus,** and has not involved the peritoneum over it, we are guided by the usual behavior of such structures in inflammation, that is, whether the danger of operation is greater or less than non-operative treatment. All are agreed that a catarrhal appendix is better removed in anticipation of trouble. A gonorrheal tube may recover, and there is no great danger in delay.

2. **In what seem mild peritoneal inflammations about organs not likely to**

rupture the Ochsner treatment may be employed. The patient is watched with great care. Blood examinations are made frequently and are compared with changes in temperature, pulse and local examination.

The sign of greatest value in determining what is going on inside the abdomen is muscle rigidity. It is absent in colics of all kinds and usually after trauma, such as contusion of abdominal wall or organs. It is present with peritoneal irritation, whether this is due to inflammation or is chemical. I have seen the whole abdomen rigid a few minutes after rupture of a gastric ulcer. Rigidity, pulse, vomiting, and facies in the order mentioned are reliable signs of trouble. Of greatly less importance are leukocyte count, temperature and pain. Pain is notoriously unreliable, as any inflamed organ gives it, while its cessation may mean either improvement or gangrene. Taken by itself, the leukocyte count is a poor guide to the degree of peritoneal involvement, for an increase may occur with localization and abscess formation or may mean an increase of an inflammation in an organ rather than the peritoneum. A leukocytosis following a stab wound could mean either a peritonitis or an infection of the abdominal wall.

It is unfortunate that it is so difficult to impress the student and practitioner with the significance and value of abdominal rigidity (a protective reflex) as a sign of an underlying peritoneal irritation. The difficulty arises because we have no standard of comparison. Its degree and extent cannot be stated in figures as can pulse-rate, temperature, leukocyte count and blood-pressure, but is learned only by experience in examining many abdomens. No little training is necessary to differentiate true muscle rigidity from contractions of muscles from ticklishness or those that are voluntary or hysteric.

3. **When a hollow viscus has perforated,** operate at once and close the leak. It is questionable whether the condition of shock resulting from the rupture and intraperitoneal discharge of visceral contents ever warrants a delay of even a few hours. It cannot be denied that nature may close these openings, as in some bullet wounds of the intestine, but the brilliance of operative results diminishes as the time from rupture increases. This is nowhere more evident than in acute gastric and duodenal perforations.

4. **An intraperitoneal abscess** demands incision and drainage. Experience has taught that these abscesses can be opened safely transperitoneally without waiting for them to reach such size that opening does not invade the free cavity. A moderate delay is usually not hazardous, that is, the patient can be sent to a hospital. Occasionally it may be wise to postpone operation in a pelvic abscess in women. When the abscess is small, it may be difficult to reach and to drain through the culdesac of Douglas. A few days later it may be done safely with little anesthetic and a laparotomy is avoided.

5. **Diffuse, spreading or general peritonitis** should be operated on at once except when the patient is in extremis. The results will depend in a large measure on the duration of the peritonitis. Murphy's good results (2 deaths in 51 cases of "general free suppurative" peritonitis) were obtained in patients

all of whom were operated on within 40 hours of rupture of appendix, stomach, or intestine.

I should hesitate to recommend the Ochsner treatment in any case where a spreading, diffuse, or suppurative peritonitis was believed to be present, but, as he has emphasized, the operative results will vary largely according to the patient's surroundings, the period of the disease and the operator's skill.

OPERATIVE TREATMENT

Preparation.—No food should be administered before operation, but if there is food in the stomach, or regurgitated intestinal contents, a stomach washing should be done just before the anesthetic is given. A struggle with the patient should be avoided if possible, and this is usually possible if the lavage is given in a skillful manner. As the saving of time is important, the iodin disinfection of the skin is to be recommended, as it can be applied while the anesthetic is being administered. Ether, by the drop method or closed cone, is the anesthetic of choice. It is safer than chloroform. It is to be given in as small a quantity as possible. It is best to have the patient on the operating table when the etherization is begun, so that the draping and skin disinfection can be carried on while the ether is being given. Everything should be at hand, so that the incision can be made without delay when sufficient ether has been administered. Operation under local anesthesia may be considered when vomiting is excessive and when one fears for the effect of a general anesthetic. However, cases too sick to stand a short light ether anesthesia are usually hopeless ones.

Incisions.—The location of the incision is determined by the location of the infecting focus and our ability to satisfactorily drain through it. Thus, if the history or examination indicates stomach, gall-bladder, or appendix as the starting point of an infection, the incision is placed over the offending organ. If drainage is indicated, an incision so placed will probably be where it is most needed for drainage. When there is no guide to the origin of the peritonitis, the median hypogastric incision would surely be selected in women. In men we might select the right iliac or right rectus incision because of the great frequency of appendix trouble. The work can often be well done through a McBurney, Kammerer, rectus muscle, or other incision of the kind that rarely leads to hernia. As the wounds are so frequently infected ones, the question of hernia depends very largely on the type of incision.

The small incision possesses great advantages in peritonitis. A large incision, to begin with, will often be followed by a prolapse of bowel and valuable time is consumed in a more or less successful effort to replace it. Large quantities of fluid are as readily evacuated through a small as a large incision—at times, better, for a prolapsing coil of gut may effectively block the wound. When the wound is large, a part of it will require suturing at the end of operation. This consumes time, and the sutured portion will very likely suppurate, but if a long wound is not sutured, there is the ever present and serious danger of subsequent prolapse and strangulation of bowel. Whether we irrigate or do not irrigate, the fluid is as well evacuated through the short incision. But when the original incision is not ideally placed with reference to the focus of infection, we may very likely be forced to enlarge in one direction or another, with a view to removing the focus more expeditiously. The more one learns to depend on his sense of touch in peritonitis, the less will he be handicapped by a small incision. Given a peritonitis secondary to an infected Fallopian tube, one operator may reach down into the pelvis, separate the tube by sense of touch and draw it up into view without loss of time and without exposure of gut. Another makes a larger incision (6 in. or more), has to resort to the Trendelenburg posture, retracts the wound widely, seeks to restrain the distended gut by use of many pads, and finally sees the offending organ, but even then may be compelled to separate its most adherent under portion by touch alone.

The operation will be described under:

1. The operation with diffuse peritonitis.
2. The operation with intraperitoneal abscess (see page 495).

Operation with Diffuse Peritonitis

The abdomen being opened, free fluid is allowed to escape, while the surgeon, instead of baling, washing or sponging it away, starts at once for the focus of infection. When this is found the treatment of it may vary according to conditions. The treatment of each particular organ is discussed in the chapter of this book dealing with that organ, and only general principles can be considered here. Our object is to stop the throwing of bacteria and their products upon the peritoneum. This is accomplished by (1) suture of openings in stomach, intestine, bladder, etc.; (2) removal of the diseased organ, appendix, Fallopian tube, gall-bladder, etc.; (3) drainage of such a viscus as the gall-bladder, in case it cannot be safely removed; (4) as soon as possible rendering the organ extraperitoneal by means of packing, or establishing a fistula opening externally in case closing of the visceral opening is impossible. This last is a hazardous procedure, only to be resorted to if no other is possible. It is almost confined to perforations of carcinomatous gut. The procedure to be selected must depend on a number of factors. If the patient's condition is very desperate, the peritonitis is treated and drainage established to the diseased organ without attempting to remove it. It is to be remembered that peritonitis greatly obscures normal anatomy, so that a cholecystectomy or hysterectomy may be much more dangerous than in the absence of peritonitis, both because of the obscured anatomy and hence possible injury of important structures and because of the patient's inability to withstand prolonged operation. The treatment of the peritonitis per se then consists in (1) evacuation of fluid and relief of tension; (2) removal of the focus or isolation of it from the peritoneal cavity.

Removal of the Exudate.—Much difference of practice has prevailed in regard to the method of removing the exudate. We may consider first the irrigation and then the non-irrigation method.

IRRIGATION.—Irrigation of the peritoneum is done in a variety of ways, perhaps most often by pouring the salt solution from a pitcher. It may be done by means of an irrigating jar to which a Chamberlain's glass tube or other nozzle is attached. Blake has devised a return flow irrigator, the return flow of which depends on siphonage (Fig. 1). Blake outlines the operative treatment of diffuse peritonitis as follows:

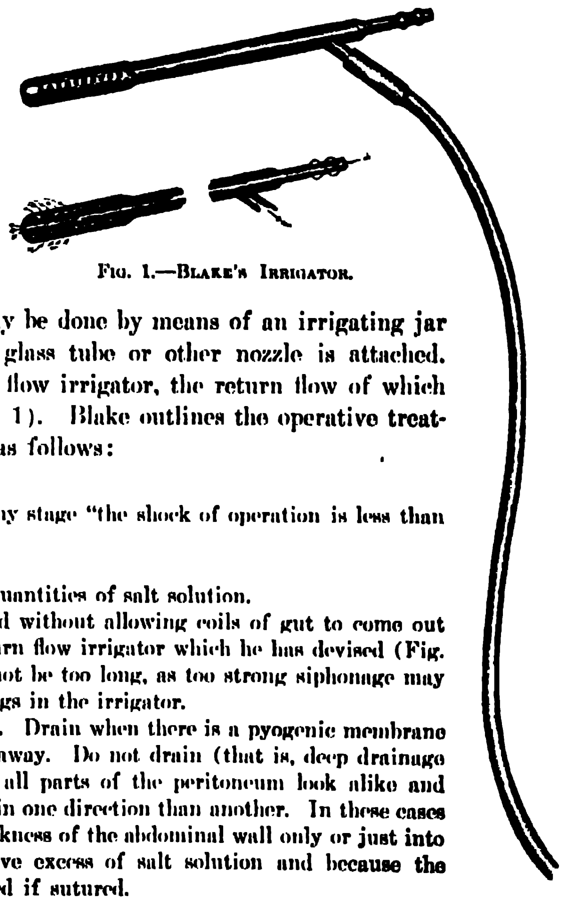

FIG. 1.—BLAKE'S IRRIGATOR.

1. Early operation. At any stage "the shock of operation is less than the danger of delay."
2. Small incision.
3. Irrigation with large quantities of salt solution.

The irrigation is performed without allowing coils of gut to come out of the abdomen, using the return flow irrigator which he has devised (Fig. 1). The outflow tube should not be too long, as too strong siphonage may draw omentum into the openings in the irrigator.

4. Drainage in some cases. Drain when there is a pyogenic membrane or any tissue that must come away. Do not drain (that is, deep drainage well into the abdomen) when all parts of the peritoneum look alike and drainage is no more indicated in one direction than another. In these cases a drain passes through the thickness of the abdominal wall only or just into the peritoneal cavity to remove excess of salt solution and because the wound is so frequently infected if sutured.
5. After-treatment. Practically the Ochsner treatment. No great emphasis laid on posture, though the Fowler is usually employed for the patient's comfort rather than for drainage.
6. Salines by rectum. He mentions irrigation of the pelvic colon through 2 long rubber tubes; the outflow one being the larger. The tubes are left in and every 3 to 4 hours, for the first 48 hours, a slow irrigation is kept up, 30 to 40 minutes; the temperature of the fluid is 110° to 115°.

Many objections are urged against the irrigation treatment of peritonitis, and it seems at present to have few advocates. Among the objections are the following: It consumes time where economy of time is a great consideration; a prolonged irrigation in itself produces shock to the patient; there are quite as good results reported without it as with it; there is danger of spreading infection; the greater part of the fluid is evacuated without resort to irrigation, and no irrigation can possibly remove all infection, hence, in any case, the cure must finally depend on natural defenses to infection. The question then is, will the removal of a slightly greater quantity of infectious material by irrigation than without it be worth the added time spent in its accomplishment? A much stronger argument for its use can be made when gastric contents, urine or feces have contaminated the peritoneum. Some who do not employ irrigation for the removal of exudate still use it for the removal of foreign matter. It may reasonably be urged that such material can be removed with less trauma to the peritoneal surface by gentle irrigation than by wiping or sponging. But even for these cases, it seems not to be employed by many American surgeons. I have never performed a systematic irrigation of an abdomen.

NON-IRRIGATION METHODS.—Without irrigation, the fluid is removed in a number of ways. In most cases, owing to intestinal distention, there is, when the coils of gut are kept in the abdomen, a distinct intra-abdominal pressure which forces fluids in the vicinity of the wound toward it. This is illustrated when the first nick in the peritoneum is followed by a jet of fluid. Each respiration increases this pressure. Fluid in the depths of the pelvis and other deep parts of the abdomen is not so removed, but if a tube is inserted through the wound to those deeper spots the pressure of the intestines is brought to bear on the surface of the fluid and it flows up through the tube. The same is accomplished when a finger or sponge-holder is passed to these collections of fluid—the fluid flows out along the instrument. In practice we find that by the time the focus of infection has been attended to, the greater part of the fluid has usually escaped. Sponging is resorted to chiefly when fluid obscures the operative field and keeps us from a satisfactory sight of the part we are working on, or when there is a slight fecal contamination, circumscribed to the region of the intestinal perforation. Rubbing or wiping peritoneal surfaces is not to be recommended. One should not attempt to pick off, wash off, or wipe off adherent flakes of fibrin.

If one is dissatisfied with the non-irrigation methods of removing exudate already mentioned, he may employ the method of continuous aspiration described elsewhere in this work (Vol. I, Chap. VII). It works quickly and "the sucker" can often be evacuating the fluid in pelvis or loin while the surgeon is doing other work. The apparatus may not always be at hand either in a hospital or house or may be out of order, so that surgeons will do well not to become too dependent on its use.

Drainage.—When the infected organ has been attended to and the peritoneal fluid has been largely removed, the question of drainage arises. Murphy has been an exponent of the drainage treatment of peritonitis. Murphy's method may be outlined as follows:

1. "Get in quickly—get out quicker."
2. Incision over focus—enlarge as needed.
3. Remove appendix; close leak, etc. Never leave a perforation patent, depending upon drainage.
4. "Relief of pus tension is the first surgical step toward retarding absorption in all acute infections. The maintenance of low pressure in every pus pocket is a *sine qua non* to continued freedom from absorption. Reduction of tension must be initial and the absence of pressure continuous. These purposes are accomplished by drainage."
5. Fenestrated or split tubes are inserted to the infected focus and also to the floor of the pelvis.
6. Proctoclysis by the method to be described later.

"The pus discharges from the tube for many days in some cases and only for a short time in others. The tube does not become rapidly circumscribed by agglutination if the pus is virulent, notwithstanding some of the recent teachings, based on animal experiments."

Murphy does not employ irrigation, even when stomach contents with food remnants and intestinal contents (as in typhoid cases) have befouled the cavity.

There seems to be comparatively little difference of opinion at present as to the need and methods of drainage. With all operators the amount of drainage material has been very much diminished in recent years. When a few years ago several large handkerchiefs of gauze were tucked into the abdomen in various directions and led out through the wound by one corner only, mechanical ileus was added to peritonitis. Moreover, these drains could not be removed for many days without an anesthetic. Many cases of peritonitis can recover without drainage, the wound being tightly sutured. If the focus is removed early enough, the peritoneum takes care of the remaining fluid and infection. On the other hand, we may be glad to drain off through a wound a toxic fluid which without such drainage must be otherwise disposed of after absorption. The question at once arises of the possibility of continued drainage of the cavity. **Experimental evidence is all one way in this matter, namely, that any drain becomes isolated from the cavity in a time measured by hours rather than days and that, once this is accomplished, the peritoneum must handle an infection in the way it would have if no drain had been used.** Murphy, as quoted above, believes that drainage of the free cavity continues when peritonitis is present.

There is, however, a period of at least a few hours during which drainage can continue, and it is a question whether this additional drainage, that is, additional to that at operation, may not turn the tide in some patient's favor. If the purpose is simply to drain off this additional quantity of fluid, a drain need go no further than just into the peritoneum.

Max Fischer, who reports 160 cases of peritonitis operated on in 10 years, seems to follow this course. He abandoned primary closure of the wound because of a number of cases that required re-operation and now drains all cases, but in many **removes the drain in 24 hours**, his guide being the character of the exudate. If it inclines to be watery or serous, he removes the drain. He removes it later or replaces a drain when the exudate is more purulent.

If, however, there is an infected stump or a pyogenic membrane or if there is great danger of a suture line giving way, a drain is placed to it, our purpose being to get a drainage tract established from the potential focus of trouble to the skin surface. Failure to drain in such cases will result in an abscess formation about the suspicious spot, and usually there will be an infected abdominal wound. Those who believe with Murphy in our ability to drain the general cavity for several days will also place a drain in the pelvis and seek to make fluid gravitate toward the drain.

CASE: At operation on a subacute appendix, the thickened, inflamed organ was dug out of a bed largely retrocecal. There was no pus, and the wound was closed. The reaction was considerable, temperature and tenderness continued for several days, but finally subsided without suppuration even in the abdominal wall. Had a small drain been inserted, the blood and exudate from the cavity would have been removed externally, but under the circumstances had to be handled by the peritoneum. In this case we were not closing up a normal peritoneal cavity but one communicating with an oozing connective tissue space. A small drain would have lessened the reaction by relieving the peritoneum of some of the exudate which it had to handle.

DRAINS IN SPREADING PERITONITIS.—The glass drainage tube has lost its popularity owing to its well-known dangers. The same is true to a less extent of the stiff rubber tube. Instead we use the soft rubber tube split along 1 side or spirally, or the fenestrated tube. Any of these may cover a strip of gauze. The cigarette drain of Morris is popular, but old and friable pieces of rubber should not be used. A folded piece of rubber dam will answer just as well as a drain if it does not inclose gauze. At any rate, unprotected gauze should not be used, as it will only drain thin fluid and is too difficult to remove.

Evisceration and Enterostomy.—Surgeons in general are opposed to evisceration in peritonitis as being productive of shock. The easiest way to prevent it is to work through small incisions. It is better to be cautious and not let gut escape than to have to waste valuable time in replacing it. In practice enterostomy or cecostomy to relieve the distention will prove disappointing. A single opening will only empty a small segment of gut, and to empty more through the opening requires evisceration and stripping of the gut. It should not be attempted. Mechanical ileus, however, when resulting from peritonitis, may require enterostomy.

Wound Closure.—The portion of the wound not actually occupied by a drain should be sutured to prevent prolapse of gut. A few silkworm-gut sutures through the thickness of the abdominal wall answer this purpose.

Postoperative Treatment

The patient is placed in bed, usually with the head and shoulders elevated as tending to give greater comfort and, when the peritonitis has originated in the lower half of the abdomen, as favoring the motion of fluids toward the drain if one has been inserted. If the incision is in the right or left iliac region, the patient may be turned to the corresponding side with the idea of favoring drainage and localization. When the process has had its origin in the upper abdomen and a drain has been left in this region only, it would seem wiser not to practice elevation of the shoulders.

Posture in Peritonitis; Postural Drainage.—The belief in actual holes or stomata in the diaphragm leading to mediastinal lymphatics seems to have been largely abandoned, but the belief in a steady stream of peritoneal fluid toward the diaphragm, which was based on the belief in diaphragmatic stomata, is still widely entertained. Further, these observations regarding diaphragmatic stomata have focused attention on lymphatic absorption to the neglect of vascular absorption.

The work of Muscatello and others showed that fine insoluble particles are taken up by the lymphatics of the diaphragm in a surprisingly short time. If sufficiently fine particles of lamp black (India ink emulsion) are injected into a guinea pig's pelvis and the pig held erect, most of the fluid, by gravity, remains in the pelvis, but even when the animal was killed in 7 minutes I have seen the anterior mediastinal lymphatics appear as 2 hair-sized black lines with distinct blackening of the lymph nodes behind the manubrium. The first particles lie in lymph spaces and are extracellular, as was emphasized by Buxton and Torry, i. e. they reach the lymphatics before the establishment of a leukocytosis. Probably but a portion of the lamp black would be removed and the remainder would be encapsulated.

Dandy and Rowntree say that when the insoluble pigment phenolsulphonephthalein is injected intraperitoneally only 0.1 per cent. of it appears in the lymph of the thoracic duct, and this only after 20 minutes to an hour. But it is a fact that the insoluble particles of lamp black appear in the mediastinal nodes much earlier and in considerable quantities. Peritoneal diffusion is rapid and there seems little doubt that the contention of Dandy and Rowntree is true, that vascular absorption from the peritoneum is much more important than lymphatic absorption.

In spite of preconceptions, there seems little evidence of a definite stream of fluid making toward the diaphragm. Secretion and absorption no doubt take place in all parts of the peritoneum. If vascular absorption is greater in one part of the peritoneum than another, it is probably the omental portion. This is indicated by its large vascular supply and its observed behavior in peritonitis. It may be that in inflammations of a portion of the peritoneum (for instance, about an appendix) the inflamed peritoneum is actively secreting, while the adjacent and distant non-inflamed peritoneum is engaged in absorption, thus to some extent determining a stream of peritoneal fluid away from the lesion. Aside from such a process **diffusion in the peritoneal cavity is favored by capillarity, peristalsis and respiration and is favored, or the reverse, by gravity, as the case may be.**

Before peristalsis has been inhibited by the inflammatory process in peritonitis, diffusion may have carried the exudate to very distant portions of the peritoneal cavity, and in the absence of an external vent the exudate is absorbed by lymphatics and blood-vessels. The early widespread diffusion is illustrated by the following clinical case.

Case: A girl who had been treated for gastric ulcer was seized with severe pain in the epigastrium, and, under the diagnosis of gastric ulcer, was operated on within 6 hours through an epigastric incision. Turbid fluid bathed the peritoneum all about the stomach, but the peritoneum was not injected. An incision was then made over the appendix, and an acutely inflamed one was found and removed. The wounds were closed without drainage, and the temperature thereafter did not exceed 100° F. Thus, within 6 hours, in an appendix case that did not appear particularly severe, turbid fluid had diffused to the most distant part of the abdomen.

Posture, then, does not institute drainage or diffusion in the closed abdomen, but works either to accelerate or retard its natural course. Clark of Philadelphia advocated a posture to aid the supposed natural drainage toward the diaphragm. At operation he left a liter of salt solution in the peritoneal cavity and raised the foot of the bed with the idea of diluting and hastening the removal of bacteria to other parts of the body for destruction. He did not, however, recommend this posture in peritonitis. Of course the elevation of the pelvis recommended by Clark could not be enough to mechanically pour an accumulation of fluid from the pelvis into the abdomen, but only enough to favor the supposed natural drainage. Apparently, however, nature's method is not to remove bacteria which enter the peritoneum in moderate numbers to the organs for destruction, but to do it on the spot. Buxton injected typhoid bacilli into the peritoneum and says: "There may be an explosive destruction of the vast majority of the bacilli, few or none reaching the organs in such cases. . . . The destruction may take place more slowly, though still strikingly manifest, within one hour after inoculation."

Fowler in 1900 described his postural treatment of peritonitis, which reversed Clark's. He reports 9 consecutive cases of diffuse peritonitis treated by operation with irrigation with peroxid of hydrogen and bicarbonate of soda solution, with or without evisceration, and extensively drained (in one case with 21 gauze strips inserted in all directions), without a death. All were subjected to the Fowler position. During the same time, 9 cases were treated in the same manner, but without the elevation of the bed, among which were 5 fatalities. The position recommended by Fowler is that of a bed whose head was raised 12 to 15 in. A pillow is folded under the thighs, and by means of a bandage it is secured to the head of the bed to keep the patient from sliding down.

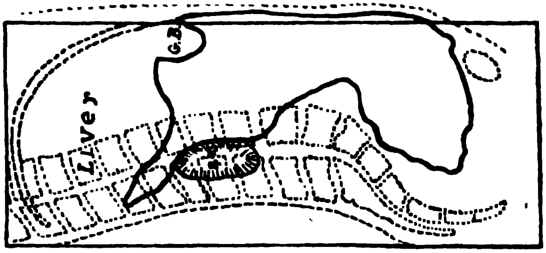

FIG. 2.—DEPTH OF PELVIS AND RIGHT LUMBAR GUTTER. After Coffey.

Coffey has shown that the inclination of the plane from the pelvic brim to the outer side of the colon down to the right kidney region—the right peritoneal gutter—is inclined 51° to the horizon, and with the patient horizontal is about as deep as the cul-desac of Douglas (Figs. 2, 3). To empty this space mechanically, then, the patient must be elevated to at least 51°. The Fowler position produces a rise of only 10° to 15°. Fowler advised the position in order to bring the fluids by gravity into the pelvis, where they would not be readily absorbed. Seeing that such a moderate elevation would not do this, many others have resorted to a posture which is practically a sitting one. For this, special bed rests or beds have been devised, of which the Gatch is a good example (Fig. 4). Nothing short of a half sitting position can be considered as producing efficient mechanical drainage into the pelvis. Even admitting that there is a natural drainage of free fluid toward the diaphragm, it seems unreasonable to suppose that either the position of Clark or Fowler, with their very moderate elevation, could have been very important factors in mechanically draining out of or into the pelvis.

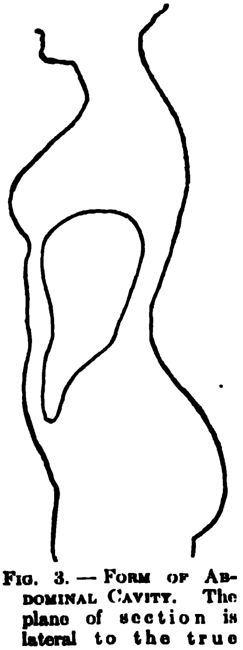

FIG. 3. — FORM OF ABDOMINAL CAVITY. The plane of section is lateral to the true pelvis.

To the sitting position—the exaggerated Fowler—which has now become popular, there are important objections. The position of rest is lying down, and no matter how it is maintained, the sitting position would seem to tax the patient's strength and especially increase the heart's work. The position is tiring and difficult to maintain, and the patient voluntarily and involuntarily slips down or to the side. This does not apply to the original moderate elevation, and a patient with tympanites finds it much more comfortable than a horizontal one. If one wishes gravity drainage, at least in appendix cases, why not use the moderate Fowler with the patient lying on the right side? I think the importance of posture has recently been overstated and believe that the sitting position does more harm than good and that the Clark and Fowler positions are too moderate in amount to more than slightly accelerate or retard the natural diffusion of free fluid over the peritoneal surface. However, I see no objection to the Fowler position and use it in the belief that it considerably aids the breathing and comfort of the

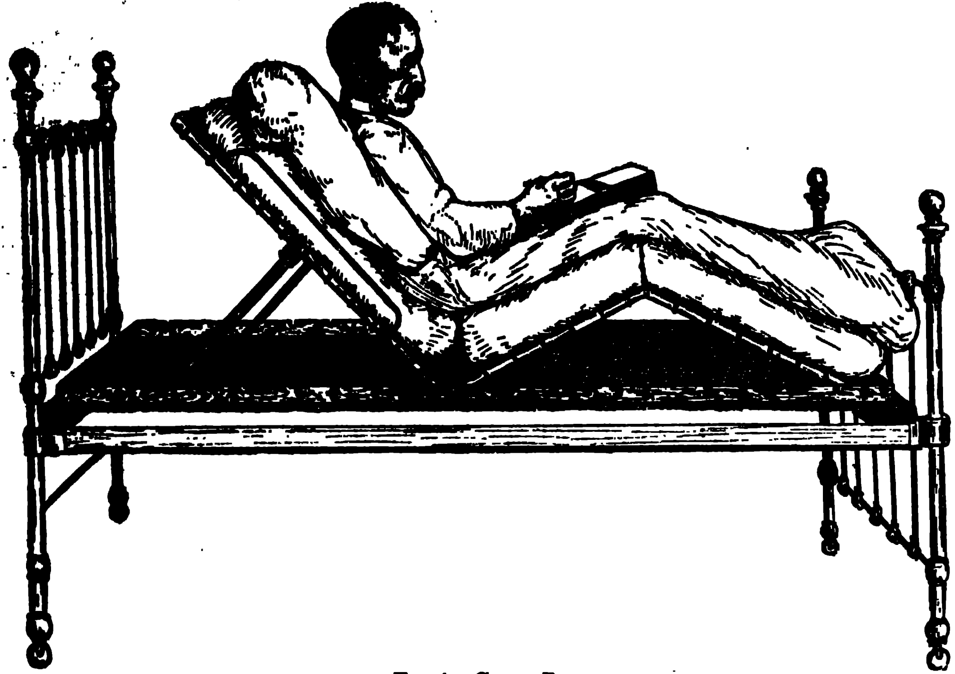

FIG. 4.—GATCH BED.

patient. I advise its use therefore, though not for Fowler's reasons. Blake says of postural drainage:

> "I have found it useful when considerable fluid was left in the abdomen and a drain has been introduced. In these cases I elevate the head of the bed if the drain is in the pelvis; the foot, if in the upper part of the abdomen, otherwise, I have not employed it."

Yates says:

> "Postural methods in the limitation of diffusion are of indisputable value but are of secondary importance compared to the maintenance of blood pressure sufficient to support life, and are frequently more extreme and continued longer than is necessary or even beneficial. Indeed, a lateral or dorsal horizontal position in many instances gives better results."

Administration of Fluids.—It is important that fluid should be given the patient as soon as possible, since the removal of toxic products of bacteria is dependent on elimination through skin, kidneys, and lungs. There is discomfort from thirst of which the patients complain more bitterly than of anything else. Unfortunately, the stomach cannot be utilized, as the nausea of the disease is added to by that caused by the anesthetic. Hence, operators in their more serious cases make an effort to replenish the supply of fluid by artificial means.

1. INTRAVENOUS INFUSION.—Some employ intravenous infusion, using the 0.9 per cent. of $NaCl$ or other fluid isotonic with blood serum, the usual modification being an addition of small amounts of KCl or $CaCl_2$ to the salt solution, as more nearly representing the saline constitution of blood-plasma. It must be remembered, however, that no fluid that we use can closely approximate blood-serum, and that even in cases of infusion for blood loss the fluid begins to be and is very rapidly eliminated by skin and kidney even when to our point of view the body needs the fluid. It seems likely, then, that saline as we use it is not an altogether innocuous fluid.

2. HYPODERMOCLYSIS.—Hypodermoclysis has advantages over intravenous infusion. When given beneath the breasts, fluid is so rapidly absorbed that intravenous infusion offers no great advantage as to speed. It can be given easily during the progress of the operation without disturbing the operator; moreover, it had better be given then so as to relieve the patient of even the moderate pain of its administration. A single hypodermoclysis usually suffices, and subsequent administration of fluid is continued by rectum.

3. PROCTOCLYSIS.—Fluid may be given in ℥vi to ℥viii quantities every few hours or by the method of proctoclysis commonly spoken of as the "Murphy drip." The Murphy method, however, as employed in our hospitals, is not by any means given uniformly with attention to the details on which Murphy lays great stress. The modifications which have been suggested usually complicate rather than simplify both the method and the apparatus. Chief among the modifications are means for heating the fluid. Some want the fluid to be as hot as the patient can tolerate, though this seems unnecessary when the patient is already suffering from fever. If given according to Murphy's technic, fluid at 100° to 110° F. at the beginning may be absorbed before falling to room temperature, and it would seem that no harm would be done if it did drop to 70° or 80°.

Murphy describes his method of proctoclysis as follows: Hyperdistention of the rectum causes spasm and expulsion. "The apparatus in its simplest form consists of a fountain syringe with a large rubber tube attached, terminating in a vaginal hard rubber or glass tip flexed at an obtuse angle 2 in. from its tip, having numerous openings in its bulbed end." The base of the fluid container should be about 6 in. above the patient's buttocks. The temperature of the fluid is 100° F., and each pint of fluid contains a dram each of sodium and calcium chlorid. "The apparatus may not be disturbed for several days." As to the quantity absorbed, "the average is 18 pints in 24 hours. I believe a quantity of less than 8 pints is of little value." "Proctoclysis is usually continued for 3 days." The patient should be in the Fowler position. "Place 1½ pints in the container every 2 hours. The container should be elevated sufficiently to allow this all to flow into the rectum in 40 to 60 minutes, giving the rectum a period of rest from the influx of fresh fluid for approximately an hour." It should have a hydrostatic pressure of 4 to 7 in., never more than 15 in. If any means other than gravity is used to control the flow of fluid into the rectum, fluid will be discharged into the bed when any expulsive effort is made; on the other hand, with only 6 in. of elevation of the bag, fluid is driven back into the bag if the nozzle is provided with

many holes. The fluid flows back and forth and cannot excite peristalsis by distention of the rectum if the details of the method are followed.

If the fluid in the container becomes discolored or clouded with feces, it may be considered certain that the apparatus is working as Murphy recommends. From what seems to have been force of habit, fluid given by rectum seems usually to be saline solution. But the purpose for which we give it is to relieve thirst and supply fluid quickly. Water without salt is more thirst relieving and more rapidly absorbed. We would not think of giving saline by mouth in preference to water for this purpose. Why, then, do it by rectum? The quantity of fluid which Murphy says is absorbed by his method of administration seems very large. It is more than we could usually induce a well person to take by mouth, but he says lack of success with the method is almost surely due to a failure to follow out the details of the treatment. I am unable to say just how much fluid I have seen absorbed in this way, but it is much under Murphy's average. Nurses are depended upon for the actual carrying out of the method, and there are many sources of error in computing the amount actually absorbed. However, I rarely see one of these patients eliminate ℥l of urine in the first 24 hours after operation. Murphy does not say how much urine his patients eliminate. In a recent severe case I watched the details of the administration and saw that fluid ran back and forth from the container, but the amount absorbed in 24 hours was under 4 pints. It would seem reasonable to suppose that the quantity absorbed would vary according to the patient's needs.

Postoperative Vomiting.—Drugs for the relief of postoperative vomiting are of no value. The tendency to vomiting is a little less when the head and shoulders are raised. No food should ever be administered while nausea continues. The method of giving a large quantity of fluid by mouth with the expectation of having it vomited and thus cleanse the stomach is not a good one in peritonitis cases. Lavage is the most efficient method of controlling vomiting. The regurgitation of small amounts of fluid by these patients every few minutes has been compared to the "incontinence of retention" in urinary bladder distention. The stomach in these cases is often full, and only a fraction of the contents is expelled with each emesis. The passage of the stomach tube may remove 10 to 20 oz., to be followed by immediate relief of vomiting, diminution of distention and improvement in pulse and respiration, so that a patient will fall asleep almost at once. It is a most satisfactory procedure in this class of cases. The operation should be done without a struggle. A mouth gag should not be used. The tube is simply wet with water and passed into the stomach with the patient turned to his side and the stomach contents are siphoned off, after which a small quantity of water is poured into the stomach and siphoned off. This is repeated twice.

The mouth should be kept clean and moist by means of mechanical measures and mouth washes. When nausea has about subsided, we begin to give water, hot, cold, or carbonated, in doses of 1 to several drams frequently repeated. The first nourishment should be albumen water or milk and lime water, to be followed later by broths. Nausea is likely to last as long as there is tympanites, and the means employed for its control are useful for the nausea as well.

Tympanites.—This is a serious complication in peritonitis and always demands careful consideration. First and most important in its treatment is the enema. If the colon is capable of any peristalsis, the fluid is carried around to the ileocecal region, but in its absence it is impossible to tell how far the fluid goes. At times there is no expulsive power, and the fluid must be siphoned off. Great care should be used in adding such medicaments as glycerin, turpentine, alum, ox gall, etc., to the water, as they may cause considerable irritation, setting up a colitis after the peritonitis has subsided. Cathartics are to be used with great caution if at all, for they may precipitate an acute mechanical obstruction. We cannot feel safe in using them until we have succeeded in getting a result from the enemata. A patient who has been without vomiting for some time may be started vomiting again by a dose of calomel.

Some operators believe that we can succeed with an irrigation where simple enemas have failed. For this purpose, 2 tubes are used, one just inside the anus, the other inserted as high as possible. With the patient turned to the side, several gallons of fluid are passed slowly into one tube and are allowed to flow out through the other. The colon is occasionally distended by compressing the outflow tube.

Poultices and stupes are applied to the abdomen. Their effect is nearly negligible. Perhaps through the heat applied they may slightly stimulate peristalsis.

The drugs of most value are eserin and pituitrin. It is well to administer a dose of one or the other a half hour before an enema is given in bad cases. Eserin is used in doses of 1/50 gr. Pituitrin is said to contract the blood vessels, raise blood-pressure and increase peristalsis. It may be given intravenously in salt solution or hypodermically. In the latter case the dose is 0.4 gm. (2 c. c. extract hypophysis of Burroughs Welcome & Co.; 2 c. c. piturtarin of Parke Davis & Co.). My personal experience is limited, but I believe it the best drug we possess for exciting peristalsis. Heart stimulants will be found unsatisfactory. Adrenalin would seem to be indicated as a vasoconstrictor, but we have no method of continuous administration. If given in any way but intravenously it is said to have no effect on blood-pressure.

Morphin is to be used sparingly. Some, like Deaver, say that it should never be given after a peritonitis operation. Most surgeons do not object to a single hypodermic given when the patient is most restless a few hours after operation.

RESULT OF TREATMENT

In detailing the methods of treatment I have not sought to conceal a personal bias for or against various measures. Where such differences of opinion prevail, however, it is only fair to state that with the recognized general improvement of results in recent years equally good results are claimed by surgeons employing widely differing methods.

If an appendix is inflamed and there is widespread turbid fluid, but the peritoneum is little injected and presents a glistening surface, are we to call the case one of spreading peritonitis? The removal of the appendix without washing or drainage in such cases will usually be followed by a placid recovery. The operators reporting statistics as a rule disclaim including cases of this sort in their tables. They usually tell us that beside the nidus of infection pus was present and there were signs of peritoneal inflammation and no adhesions. It is very difficult to satisfy myself in what class many of my cases belong. Many of the worst show very distinct walling off in some direction or other, while some cases without any adhesions to control the free turbid fluid behave clinically as quite mild ones. Further, with the small incision and without irrigation we do not know the extent of the process.

While most surgeons advise early operation in cases of spreading peritonitis, Ochsner finds his starvation treatment especially indicated in gangrene of the appendix and diffuse peritonitis. In his hands "beginning general peritonitis" is arrested, and his published statistics tend to confirm his statements. It is to be remembered, too, that the treatment, with the exception of gastric lavage, is a "do-nothing" treatment—no water, no food by mouth, no cathartics, no enemata, no drugs (as morphin).

CASES AT THE AUGUSTANA HOSPITAL, JULY, 1901, TO APRIL, 1904

		Cases	*Deaths*	*Percentage*
Group 1.	Chronic or interval	540	3	.5
2.	Acute appendicitis with perforation	255	5	1.9
3.	Acute appendicitis perforated or gangrenous without abscess	55	0	0
4.	Acute appendicitis with abscess	117	4	3.4
5.	Acute appendicitis, diffuse peritonitis	33	10	30.
		1000	22	2.2

Of the 255 in Group 2, 55 were treated by lavage.

Of the 55 in Group 3, 34 were first starved until they seemed in safe condition for operation.

Of the 117 in Group 4, 78 were first treated by lavage.

Of the 33 in Group 5, all were treated at first by lavage. Seven were moribund and not operated upon. **Of 460 acute cases, 200 were for a time treated by the Ochsner method.**

Torek has advocated a treatment which is the antithesis of that outlined in this chapter and gives results as good as the best. He had 3 deaths (1 patient moribund; 2 patients operated on in the fourth day of peritonitis) but aside from these there were 18 successive successful results. No case died whose peritonitis was of under 70 hours' duration. All were of appendiceal origin. His treatment is as follows:

1. Incision began at pubes and terminated anywhere from 2 in. above the umbilicus to the ensiform cartilage.
2. The hand separated the coils of intestine in all parts of the abdomen, and salt solution was poured from a pitcher to wash each part of the cavity.
3. Evisceration was practiced to some extent.
4. "Rapidity of operation counts for something, although it should not be overestimated."
5. Wounds were closed without drainage.
6. Always used strychnin, nitroglycerin, etc.
7. If there was much shock, the foot of the bed was elevated.
8. Inserts the rectal tube but does not recommend cathartics or enemas.

Murphy reports 51 cases of "general free suppurative peritonitis" with 2 deaths. None of them was of over 40 hours' duration. Two were gastric, 1 duodenal, and 5 typhoid perforations. Forty-three were appendix cases. All were drained. No irrigation was used even in the typhoid cases, although he says a pint of intestinal fluid flowed through the tube from the pelvis in 1 case. All the typhoid cases recovered.

Blake's series includes:

78 cases of diffuse peritonitis due to appendicitis.
13 perforations of stomach and duodenum.
8 typhoid perforations.

These cases were operated on by 4 surgeons. Of the 13 stomach and duodenal cases 1 died of obstruction; 3, who were operated on over 36 hours after rupture, of peritonitis. Of the 8 typhoid cases there were 4 deaths; of the 78 appendix cases, 15 deaths (19 per cent.).

All cases were irrigated. Drainage had little bearing on the issue; some of the fatal cases were drained; some were not. Drainage was not extensively employed.

A series of cases of interest because of its size is that of Grekow (11) from the Obuchow Hospital of St. Petersburg. There were 900 cases with a mortality of 63 per cent. Aside from the more usual methods of treatment, oil and camphor had been used in the cavity but are not recommended. Grekow speaks more favorably, however, of the use of a 5 per cent. grape sugar solution and also of the use of hypertonic salt solution to favor exosmosis and hence an auto-flushing of the peritoneum.

Max Fischer reports the results of treatment of 160 cases operated on in the last 10 years. The series is noteworthy for the great variety of the causes of the peritonitis. Further, a large percentage of the cases seem to have reached the hospital at Olmutz late in the course of the disease. There were 160 cases with a mortality of 51 per cent.

Sources of Infection	*Cases*	*Deaths*
Appendix	107	
Perforations of stomach and duodenum	8	7
Perforations of intestine from hernia, trauma, and stab wounds	23	
Female genitals	12	7
Gall-bladder	4	3
Typhoid	2	2
Perforations from cancer, diverticulum, etc.	4	

The chief interest attaches to the appendix cases, for they are arranged in 2 groups, depending on whether they were operated on in the first 2 days or later. There were 30 cases operated on within 48 hours, with a mortality of 12.9 per cent., while 68 cases operated on at a later date gave a mortality of 54.9 per cent.

Fischer's treatment differs little from that in vogue in this country. We may epitomize it as follows:

1. Early operation.
2. Stop the infection at its source.
3. Short operation.
4. He thinks well of the camphorated oil treatment though it is not clear that he has employed it in the cases reported.
5. Prevent evisceration.
6. It makes little difference whether we employ the "dry" or the "irrigation" method of removing exudate.
7. Drains always, especially through the pouch of Douglas, **but often removes drains within 24 hours.**
8. Fowler position.
9. Salt solution by infusion, hypodermoclysis or rectum.

We should be slow to draw conclusions from small series of cases where so many factors are concerned, as, for instance, time of operation, bacteriology, etc., beside so many variants in the operation itself. Thus, if we relied on Fowler's statistics alone, we would conclude that the mortality was reduced 50 per cent. by the Fowler position, but his cases are too few to warrant such a conclusion; he treated 9 cases with it with no deaths, 9 without it with five deaths.

The following statements seem, however, to be beyond contradiction.

The mortality from the disease has been much reduced. **The only points of treatment about which there is practical unanimity are early operation, quick operation, closure of the leak or removal of the focus.**

Our conclusion, then, is that these are the essentials and, though every other procedure that may possibly aid in the patient's recovery is to be resorted to, yet drugs, irrigation, drainage, posture, etc., are comparatively of much less importance in the control of a diffuse peritonitis.

INTRAPERITONEAL ABSCESS

An abscess in the abdomen may (1) be confined to an organ, as, for instance, the liver, and have no peritonitis about it; (2) it may be confined to an organ which becomes surrounded by an encapsulating peritonitis; or (3) an abscess may be intraperitoneal, that is, have its wall made up of inflammatory tissue and modified peritoneum. The principles of treatment vary somewhat in the 3 cases.

1. The abscesses of organs are treated in other chapters of this book; it may, however, be said that in their treatment we aim to avoid infections of the peritoneal cavity. A kidney abscess or perinephritic abscess will always be operated on by such a route as will avoid the peritoneum altogether. In liver abscesses this may be impossible and the expedient of opening the abscesses by the 2-stage operation is employed, the experience of those who see many such abscesses often leading them to follow this course. It may not at first seem clear why this should be the case, when we daily open intraperitoneal abscesses transperitoneally. But in the visceral abscess the peritoneum has not instituted a reaction to infection and the amount of infection thrown on the peritoneum when the abscess is opened may be more than it can tolerate. In general, a thoroughly protective peritonitis results from a *gradual* extension of bacteria and products to the peritoneum. For this reason, when possible the 2-stage operation should be employed in such cases. If impossible, we may aspirate pus and protect the peritoneum by pads so as to limit the amount of soiling to the greatest possible degree.

2. When the peritonitis around a visceral abscess is acute, it may be the part of wisdom to delay operation until the acuteness has passed. This applies particularly to gall-bladders and pus-tubes. After the peritonitis has subsided somewhat, the operation can be done with the anatomy less obscured, with the patient suffering less from the inflammatory reaction and better immunized to the exciting germ. In a gynecological case an ovary or tube may be saved that would be sacrificed if operated upon at the height of the peritonitis. When the gall-bladder, Fallopian tube or appendix contains pus, and there is a limiting peritonitis without pus, we make an effort to remove the organ without rupture or soiling of peritoneum, but this is often impossible and pus laden with bacteria (we are not referring to the sterile pus-tubes) is spilled upon the peritoneum. It is at once taken up on a sponge and if the focus has been removed the question of a drain is considered. If the abdomen is closed without drainage, we do not fear general peritonitis from the soiling with pus, but the possible formation of an abscess. If the peritoneal surface is fairly normal and no sloughing stump of an organ remains, we can rely on the peritoneum to attend to the infection without resulting abscess. If the peritoneum is raw and its surface oozing, due to separation of adhesions, or if a sloughing stump remains, an abscess may be confidently expected. In a gall-bladder case, with oozing from the under surface of the

liver, we would feel safer with a drain down to the ligated duct. If a pus tube has been enucleated and a cavity is left denuded of peritoneum which may be expected to fill up with blood-clot, a drain will also be advisable. In these cases it is not the peritoneum that needs a drain but the sloughing stump or connective tissue cavity in contact with the peritoneum.

3. When an intraperitoneal abscess has formed, with careful treatment, the chance of its walls giving way and a general peritonitis resulting is not great. However, the abscess steadily enlarges and should be operated on as soon as possible. We have ceased to fear to any great extent the transperitoneal opening of such abscesses. When an incision has been made and free peritoneum encountered, we may follow either of 2 plans. The older is that of isolating the free cavity from the pus by placing pads around the abscess before proceeding to open it, then, when the wall of gauze has been arranged, opening the abscess with the finger and sponging away the pus. This method is quite commonly followed in the abdominal opening of pelvic abscesses and was formerly much employed in appendix abscesses. The second method is to open the abscess at first with a very small opening without the protecting pads, trusting to the pus to follow the finger or instrument toward the wound, as it usually does. This method has grown in favor as our fear of the peritoneum has diminished. The abscesses can be handled with less disturbance of adjacent coils of gut and with a smaller incision than if we felt it necessary to use protective pads. If this fear of soiling the peritoneum were carried to its extreme, it would result in our treating both pus-tubes and appendix abscesses by drainage alone and not removing the offending organs for fear of breaking the abscess wall. Instead, experience shows it to be safe to break up an abscess wall and remove the offending tube or appendix, and when we do not remove tube or appendix it is for other reasons than fear of exposing uninfected peritoneum. The more real danger is of damage to the gut when the abscess wall becomes so dense that we cannot recognize structures in it; then we drain the abscess only, with the possibility of a second operation being necessary later. The earlier the operation, the greater the probability that the focus can be attended to.

Considerable changes have arisen in regard to the methods of draining these abscesses. Not many years ago surgeons made a large incision and packed the cavity with gauze in quantities sufficient to distend the cavity to its original capacity. There was great fear of secondary abscess unless the cavity was made to heal from the bottom by packing and repacking. The removal of the gauze was painful and at times even necessitated an anesthetic. The Mikulicz method was devised to make removal comparatively painless and obviate the anesthetic. A gauze pack, however, soon becomes saturated and ceases to be of any further service as a drain, but rather becomes a plug for the wound, interfering with drainage. Now the gauze tamponade is rarely resorted to, whether the abscess is of gall-bladder, appendix, or pouch of Douglas. Instead we use the soft split tube with or without a core of gauze, the cigarette drain of Morris, or a simple folded piece of rubber dam. No attempt is made to distend the cavity, which has practically obliterated itself by collapse of its walls as soon as opened. All that is necessary is to obtain an unobstructed tract to the surface. Adhesions form around the drain very quickly, so that it becomes a definite extraperitoneal tract to the abscess. Even in the first day the drain largely stops draining, once its capillary recesses become clogged with leukocytes, and drying around the wound opening tends further to stop drainage. Thereafter drainage may be started by pulling the drain out for an inch or thereabouts or by simply twisting it. The drainage occurs around rather than through the drain. This stage being reached, the drain has ceased to be useful and becomes a detriment to drainage except in the few cases where the abdominal wall tends to close before the cavity inside has ceased to discharge.

Ordinarily in case of intraperitoneal abscess, only 1 drain is needed, and that is the one left at operation. When this is removed, say in 4 days, a tract has been established which will discharge pus till all sloughs, sutures, foreign bodies, concretions, etc., have loosened from the tissues and appeared on the surface. The exit of fluid and solids is not facilitated by repacking. An exception to this is found when the layers of the abdominal wall have not been divided in the same plane and tend to come together and close the opening, but in such cases a drain needs to go only through the abdominal wall and not into the peritoneal cavity. The pressure of intestines, together with efforts of coughing, breathing, and straining, tends to collapse the walls of the sinus and force the fluid out onto the abdominal wall, unless the opening is plugged with a drain. To illustrate by a simple intraperitoneal abscess of tubal or appendiceal origin: On the day following operation, the dressing is changed; the cigarette or tube is twisted or shortened; if there is much discharge, the outside dressings may be changed twice a day. In about 3 to 6 days the entire drain is removed. The tract is not irrigated, sponged, probed, or in any way interfered with. Gauze is laid over the wound. The following day this gauze is found soaked with pus; when the pus is wiped off the skin, it may be noticed that very little more can be got from the sinus by pressing on the abdominal wall in the vicinity. If the drain had been replaced, there would be less pus on the abdomen, but the removal of the drain would be followed by a flow of pus from the sinus.

The profuse discharge of pus will continue a variable number of days, so long, in fact, as any sloughs, sutures, concretions, or foreign bodies have failed to find exit. With the exit of the last slough the discharge suddenly diminishes, it loses its odor if it had one, and healing goes on quickly. In a few days we may begin to draw together the outside wound with adhesive straps. Experience shows that such abscesses can usually be healed within 3 weeks and one need not fear a retention abscess along the tract. Pus in the tract finds its direction of least resistance along the tract toward the opening. Secondary abscesses are often at considerable distances and are not influenced by packing the wound. Nearby abscesses tend to work toward and discharge into the drainage tract.

Incisions for Drainage and Gravity Drainage.—Intraperitoneal abscesses are usually opened through the anterior abdominal wall, the exception being those opened through the pouch of Douglas in women. It is obvious, then, that, if drained through the original wound, they drain uphill if the patient lies on his back. In spite of gravity, however, they usually close without incident or delay. In abscesses near the kidney, abscesses of gall-bladder or appendiceal origin, or abscesses in the pelvis we are tempted to make additional openings in the loin or Douglas culdesac to hasten matters by additional and gravity drainage. This is rarely necessary and usually inefficient. In a recent case of appendiceal abscess of 3 weeks' duration, a drain was passed from a McBurney incision out through a counter opening near the kidney, where the greater part of the pus lay. When the drain was removed in 4 or 5 days, the patient went on to a prompt recovery, but the loin opening closed first, almost at once, while intra-abdominal drainage continued some days longer from in front.

I do not employ the method but have seen a drain in gynecological cases inserted in a hypogastric wound and brought out through an opening in Douglas' pouch, but in all such cases one can note that the vaginal is the opening that closes first. Gravity has very little to do with the matter. Vaginal drainage finds its use not as an addition but as an alternative to abdominal drainage. We may wisely open an abscess in pelvis or tube through the culdesac, thus sparing the patient a laparotomy, or in a laparotomy when drainage is indicated we may establish it through the vaginal fornix to permit the closure of the abdominal incision.

TUBERCULOUS PERITONITIS

The treatment of tuberculous peritonitis has been continuously under discussion ever since the time when cases treated by surgical incision were found to improve in a remarkable manner. These first operations were accidental, that is, cases operated on under the diagnosis of ovarian cyst, etc. The results seemed even more remarkable then than now, for it was not considered that extensive tuberculous peritonitis could be cured by medical treatment. It is better not to consider the medical and surgical treatment as alternatives but rather as supplementing each other. All cases are subjects for the best possible medical treatment and are divisible into groups as regards the indications for surgery. In some cases incision abruptly initiates an improvement, in others there is no prospect of its doing good and a not inconsiderable one of its doing very positive harm by establishing a sinus or fecal fistula. The cases most improved are those of miliary tuberculosis with ascites and these are usually diagnosed in advance of operation. Unfortunately, those most likely to be injured by surgery are the ones undiagnosed and in which we stumble upon a tuberculous peritonitis in attacking a supposed subacute appendix.

Medical treatment need not be considered in great detail; it is the dietetic, hygienic, and medicinal treatment of tuberculosis. Care should be exercised not to send a patient liable to an obstruction too far from surgical help. The treatment must vary with the stage. In early cases rest in bed rather than exercise should be selected.

Tuberculin has greater possibilities for harm than good and should be employed only by those experienced in its use and having a knowledge of its contra-indications and dangers.

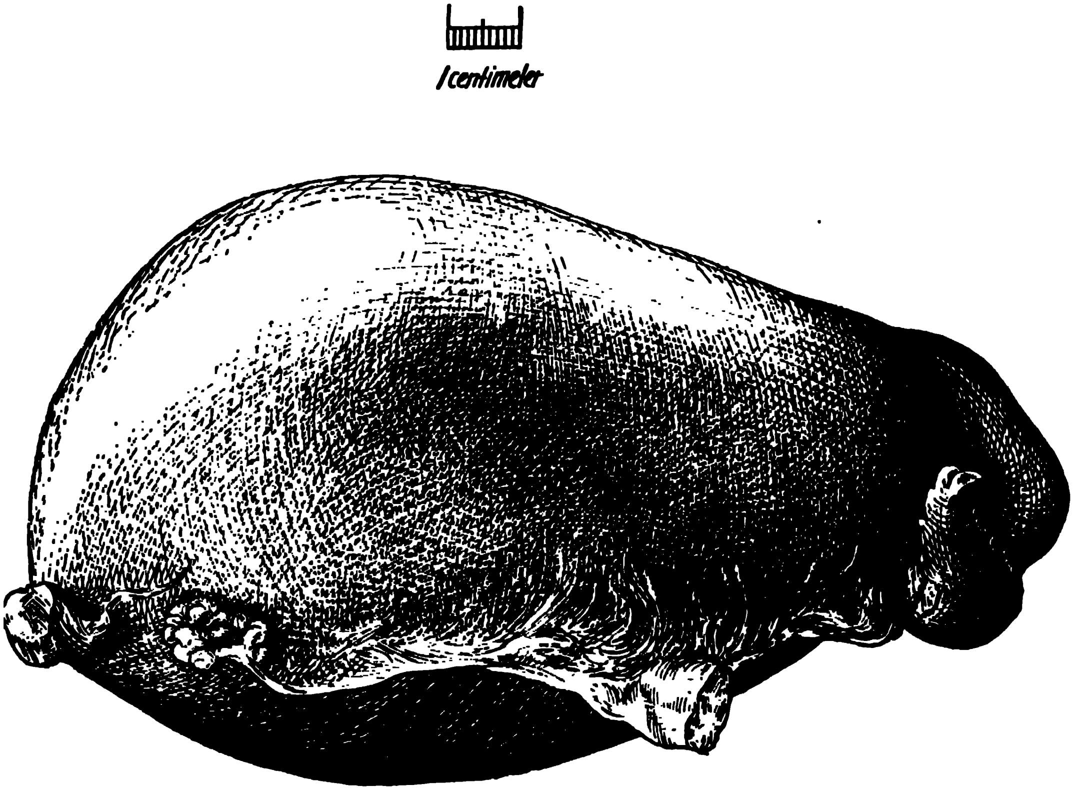

Fig. 5.—Tuberculous Sactosalpinx.

I should be disposed to try the direct effect of sunlight in addition to other treatment as it is employed elsewhere for tuberculous ulcers and sinuses. The penetrating power of sunlight is considerable as one can demonstrate by holding his hand up to strong sunlight and observing the translucent appearance of the fingers. When this treatment is first used, the abdomen must either be exposed for a very short time or with a layer of white cloth intervening to prevent sunburn.

When fluid has disappeared and there is no temperature, we may begin to substitute exercise for rest, with as much outdoor life as possible. There seems no reason to doubt that cases of tuberculous peritonitis are cured in this way without surgery. The evidence is furnished by the clinical course of the cases and by autopsy or operation performed in after years.

CASES: (a) A pair of Fallopian tubes removed from a young woman showed calcareous tubercles and web-like peritoneal adhesions but nothing to indicate active tuberculosis. (b) Three years after operation in an ascitic case I dissected out a sinus and saw upon the intestines quantities of little white spots which seemed to represent cicatrised tubercles. (c) Figure 5 is one of a pair of Fallopian tubes removed from a woman aged 30 years. It measured 9 in. along its convexity and 8½ inches in circumference. The tubes contained brownish pus and their walls showed fibrous tubercles. This patient's illness dated from a supposed "walking typhoid" 10 years before. At the operation the tubes were free from adhesions, but in their vicinity were adhesions which bespoke a former peritonitis. The peritoneal cure in this case had been complete in 10 years, and the surgical removal of the sactosalpingitis has been followed by 6 years of good health.

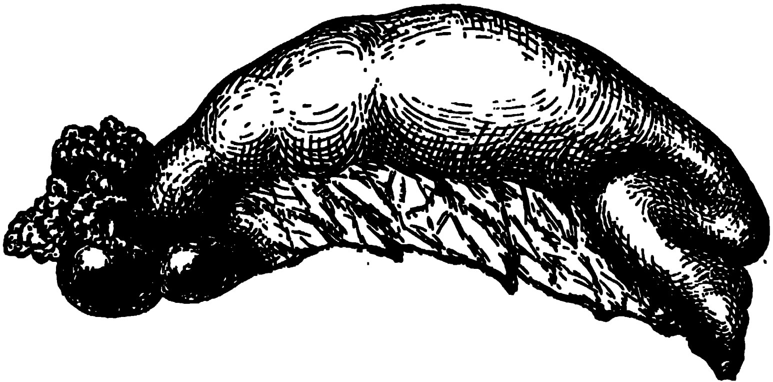

FIG. 6.—TUBERCULOUS SALPINGITIS. Abdominal osteum still patent.

The impression is widespread that tuberculous peritonitis affects females chiefly. At any rate, more women are operated on for it (in conjunction with tubal troubles) than men. The disparity may, however, be more apparent than real. That is, in many men who have it in mild form the disease may not be diagnosed and even in women the cases at times escape clinical and operative diagnosis to be revealed by microscopic examination of removed tubes. At St. Mary's Hospital for Children we have often encountered tuberculous peritonitis in hernial sacs, where it is probable that the small amount of fluid in the sac has been responsible for making the hernia evident. I have looked up the last 60 cases at St. Mary's and find that a slight majority of the patients were boys.

A word may be said as to the origin of this form of peritonitis. There are cases of miliary tuberculosis with ascites in which we find a widespread peritonitis but are unable to find a portal of entry with the means at our disposal. In children we most often find a mass in the right iliac fossa. This consists of various combinations of tuberculous processes in the cecum, lower ileum and appendix, combined with peritonitis or retrocecal lymphomatous swellings. The enlarged lymph-nodes, too, may be found around the head of the pancreas.

The researches of Park and others show that the proportion of cases of bovine abdominal tuberculosis increases in the early years, but even in children under 5 the human variety is not much less frequent than the bovine. In women the process shows its greatest development in the pelvis but it is by no means certain whether the infection of the tubes is primary or secondary to the peritonitis. The tube ends do not close early, as is the case with other forms of salpingitis. Both tubes are nearly always infected, even though the uterus may escape (the cervix nearly always does). In many cases which are diffuse, lumps consisting of coils of gut, large nodes, or thickened omentum are found in every part of the abdomen and nothing indicates the path the bacteria have traveled.

The Ascitic Variety.—This is the form in which operation has been signally beneficial. An evacuation of the fluid may be followed by no re-accumulation, or by a slight one only. In one case in which the fluid was thought to have re-formed an incision 5 weeks after the first operation showed no fluid, but the peritoneum was edematous and adhesions were ubiquitous, so that it was impossible to find a free cavity in any direction. This patient made an apparent recovery. Aspiration of the fluid is not to be recommended, but it is far from clear why incision is beneficial, and it will not be necessary to recall the various hypotheses here. Wright has said that the opsonic index of the exudate is zero. Certain it is that the result does not depend on continued drainage, for most of the cases have been treated without it and if a drain is left in it is soon isolated from the peritoneal cavity.

The Fibrous and Tubercular Variety.—Operation in these cases offers unlimited opportunities for harm. Dissection and recognition of structures are difficult. If we do not actually tear through the wall of the gut, a fistula may form spontaneously and become a very serious complication. The surgical possibilities for good are limited to the cases of this type in which the lesion is localized and may be removed, the section going through non-tuberculous tissue.

Tuberculosis of Peritoneum and Fallopian Tubes.—There is no reason to believe that the tuberculosis is an ascending one from vagina and uterus to the tubes in these cases but, the tubes once having become infected, as Murphy and William Mayo have pointed out, the cure of the peritonitis is unlikely without their removal. They re-infect the peritoneum because their ends so often remain open. The tubal removal should at least include the horn of the uterus, or a hysterectomy may be done. It should be a supravaginal one, as the cervix escapes infection and its removal may leave the patient with a tuberculous sinus opening into the vagina.

Cheesy Masses.—A cheesy gland or a tuberculous abscess should be treated, if operation is done at all, by opening it, evacuating the contents or excising the gland, and closing the abdomen without drainage and with the most careful asepsis to avoid mixed infection, as in tuberculous abscesses elsewhere.

Mixed Infections.—At St. Mary's Hospital for Children we have had a number of children with large abscesses with acute febrile history and have operated under the diagnosis of appendicitis. The diagnosis of tuberculosis has not been made until during convalescence, when nodes and masses have been felt elsewhere in the abdomen, or at a second operation to close a sinus or fistula. These are cases of pyogenic infection, perhaps of appendiceal origin, grafted onto a tuberculous peritonitis.

Operation in Peritonitis with Ascites.—An incision is usually made 2 or 3 in. long in the right rectus muscle. The fluid, which has a specific gravity of about 1.018 (more than that of a transudate and less than that of the usual inflammatory exudates), is evacuated. The abdomen is then inspected and the wound closed by sutures in layers. The suture of the wound should be as accurate as possible, so that healing may be primary and a sinus avoided. This is not always possible, as a sinus at times develops even some weeks after primary healing. Some operators recommend drainage (Ochsner *et al.*) but in the usual ascitic variety there is no part of the abdomen more in need of drainage than another, and, as is well known, we cannot drain the whole cavity for more than a few hours, because of the adhesions which form about the drain. We thus establish a tuberculous sinus the time of the closure of which cannot be predicted. If the vermiform appendix cannot be reasonably supposed to be tuberculous throughout and the starting point of the infection, and has tubercles only on its surface like the rest of the peritoneum, one should resist the temptation to remove it, as a fecal fistula may result. The Fallopian tubes, if tuberculous, should be removed, but I have not removed them prophylactically in children if the disease appeared confined to the serosa.

Operation when No Fluid Is Present.—As a rule, these cases should not be operated on. Some will be, however, under mistaken diagnoses—most often that of appendicitis. A single or small group of tuberculous glands may be dissected out of the mesentery or the appendix removed if it is the source of infection. Tuberculous tubes are operated on, as a rule, without regard to whether the peritoneum contains fluid or not, but due regard should be given to the question of tuberculosis elsewhere. It is only when the tubes constitute the chief lesion that operation is advised.

Tuberculous Fistulæ.—A tuberculous fistula usually marks the beginning of the end. Its closure by operation will tax the surgeon's resources. Failures from operation are frequent and the patient's condition after operation may be worse than before it. In children these fistulæ at times narrow down of themselves and finally close. The one case in which I was tempted to do an extensive resection in a child ended fatally. A fecal fistula had followed an appendectomy in a child with tuberculosis limited to the cecal region. Three operations by others had failed to close the fistula and had resulted in establishing other openings. The caput and ascending colon with the retrocecal nodes were removed, and a lateral anastomosis made. Death resulted in 30 hours, apparently from shock.

All cases demand prolonged medical care. Incision should be urged in the miliary ascitic variety. Aside from this, operation should be restricted to the few cases in which the lesion is discrete and single.

Prognosis.—A patient may be cured of his tuberculous peritonitis yet die of tuberculosis elsewhere.

CASE: E. M., aged 6 years, was operated on for miliary tuberculous peritonitis with ascites. The wound was closed and improvement was prompt and decided. Temperature disappeared soon after operation, and ascites did not recur. Some time afterward a sinus formed. Three years later it was dissected out when the abdomen seemed free from active tuberculosis but fine adhesions remained everywhere. Six months later she developed tuberculosis of the lung and lived for 18 months thereafter, but with no signs of abdominal tuberculosis.

The more favorable cases are the ascitic ones and here operation will usually change the peritonitis from the ascitic to the adhesive type. The patient is then in the same condition as the majority of patients who have had no ascitic stage but in whom the condition has been adhesive from the beginning. Whether an ascitic case that has been operated on is any better off 5 years later than one that has been adhesive from the start, is hard to say. Among children the adhesive and nodular type is much more common than the ascitic. Dowd says that of 40 children, mostly at St. Mary's Hospital for Children, only 7 had fluid in marked degree. When there are palpable nodules throughout a child's abdomen, the prognosis is very bad. The patients die within a few months. If a fecal fistula forms in the small intestine, the termination is much hastened. In older children or adults nature seems to show greater ability to deal with the peritonitis than with the Fallopian tubes, as is shown by the frequency with which tubes must be removed because of their size or adhesions and in which the peritonitis shows every appearance of being healed, web-like adhesions alone indicating a previous inflammatory process.

CHRONIC PERITONITIS

The treatment of chronic peritonitis resolves itself into the prevention and treatment of adhesions. Adhesions result from injury to the peritoneum, either traumatic or septic, and the adhesion process represents nature's best efforts to repair and isolate the injury. No thought need be spent in devising a method of preventing adhesions from forming when injury to the peritoneal surface has been produced. We should prevent adhesions by preventing the trauma. The success of intraperitoneal work is dependent on this very power of the peritoneum to form adhesions (recall the difference in closing an intra- and extraperitoneal leak in a viscus—the quick agglutination and adhesion of peritoneum to itself about sutures make all the difference in the 2 cases). Adhesions result from peritoneal irritation, and, as a general rule, we may say that **continued irritation continues the adhesions, but with the removal of the cause they tend to disappear.** Sometimes the disappearance is complete, at other times far from it, and we often fail to see why one case should so differ from another. Nothing is more impressive than to operate for an intraperitoneal abscess with abundance of adhesions and then after months or years to open the same abdomen for obstruction and find all the adhesions gone except the band which is responsible for the obstruction. This, however, may be firm and fibrous and cut into the compressed gut. Adhesions, too, behave much like scar tissue; an adhesion which is but occasionally exposed to traction tends to contract; while one which is subjected to a continual pull, such as that of a uterus which is sutured to the abdominal wall, tends to stretch out indefinitely. So, though we are unable to say in many cases why adhesions persist, it seems as though traction on them is an important factor favoring their disappearance. Peristalsis of both small and large intestine favors the separation of the adhesions connecting them, on the other hand, omental adhesions to an abdominal incision seem to show little tendency to lessen with time.

Prevention of Postoperative Adhesions.—All trauma, handling and exposure are to be minimized. Since even exposure to air may result in adhesions, we should aim to complete the operation in as short a time as is compatible with good work. The bad effect of air upon peritoneum seems not to depend on its chemical composition but to be wholly due to its drying effect. Steam-laden air has been found not to produce adhesions. All unnecessary exposure of peritoneal surfaces is to be avoided by short operation, keeping the organs as far as possible within the abdomen and restraining them by moist pads. Antiseptics need not be applied to peritoneal surfaces, as the bacteria can resist their action better than endothelium. Before the days of rubber gloves and aseptic surgery, one frequently saw the surgeon insert his hand into the abdomen dripping with bichlorid solution. The only fluid to be used in the abdomen is the least irritant, namely, physiological salt solution. A danger which has recently been introduced results from the use of iodin for skin sterilization. We need not give this up in abdominal surgery, and so forego its advantages, but we should avoid all excess of iodin and when structures are to be drawn out of the wound the iodin surface should be covered by thick pads of the character of Turkish toweling. As inflammation means adhesions, early operation with cure of the inflammation limits the number of adhesions; unfortunately, in this regard the prevention of adhesions is not the only and often not the most important consideration in determining the time or necessity for operation.

When we close an abdomen, the least harmful fluids to leave in the abdomen are air, blood, and salt solution. Air harms the peritoneum only when it is dry and the quantity likely to be left in at the close of an operation is negligible.

Somewhat more may be said of the practice of leaving salt solution in the abdomen. In any prolonged operation there are always some bacteria that have gained entrance to the peritoneum. These are apparently dealt with promptly by the bactericidal peritoneal fluid. Buxton speaks of their "explosive destruction"; so, though salt solution may be of use in supplying the body with needed fluid, we are diluting the protective fluid of the peritoneum as much as we dilute the few bacteria (in a clean operation). Probably, then, we favor their removal, with the absorbed fluid, for destruction in the tissues rather than their immediate destruction in the peritoneum. If our purpose is simply to supply fluid, it would seem wiser to give it hypodermically or by rectum, and I see no reason to think a peritonitis present or threatened is favorably influenced by leaving salt solution in the abdomen.

The question whether blood in the peritoneum produces adhesions has been much discussed. It clots but slowly when the peritoneum is uninjured. Experimentally it has been injected into the normal peritoneal cavity and its disappearance noted without any remaining signs in the peritoneum. On the other hand, there is the evidence of ectopic pregnancy in which we find a clot surrounded by firm adhesions within a few days. However, in most late cases of ectopic pregnancy the amount of clotted blood is not commensurate with the symptoms of hemorrhage which the patient presented at the time of rupture and we must believe that the blood has been largely absorbed before encapsulation of the remainder. It has been suggested that mild infection or the presence of the ovum accounts for the adhesions about an ectopic gestation. The matter is ably discussed in Richardson's article.

My tentative conclusions regarding blood in the peritoneum are that moderate amounts are absorbed quickly; that if adhesions do form about a clot, they are not of the firm variety and disappear almost as readily as the clot; and that there are other factors than the presence of blood concerned in the adhesions about an ectopic pregnancy. The practical conclusion is that we need not take time at operation to search through the abdomen for blood-clots, as the peritoneum takes care of them and the blood is restored to the circulation.

We should aim to leave no denuded surfaces after operation as there is abundant evidence that they favor adhesions. The ideal method is the displacing of the adjacent peritoneum to cover them. We learn by experience where the peritoneum is loosely attached and hence easily displaceable. In the pelvis, that of the anterior layer of the broad ligament is available, also that of the lower abdominal wall about the bladder. There is a redundancy, also, around the ligamentum teres of the liver which might be used to cover raw spots in the upper abdomen. The omentum also affords a supply of material for covering raw spots. Even a detached piece will probably become viable if sutured to a denuded area; however, its detachment is not usually necessary. We should not attach it so that it will produce traction or angulation of the transverse colon.

Adhesions the most to be dreaded are those of the small intestine. The small intestine is naturally isolated by the colon peripherally and the omentum anteriorly. If we always draw the omentum over the gut at the conclusion of an operation, we may avoid an adhesion of small gut to the abdominal wall. It is a wise practice in pelvic surgery to place the sigmoid and omentum so that they will roof in the pelvis and thus protect the small intestine.

There is considerable danger of producing adhesions by means of drains. In appendicitis the more lateral incision has the advantage that a drain in it will lie between the iliac fossa and colon, while a more median one to the inner side of the cecum will be in danger of contact with small intestine. When a drain is left in the pelvis, it should lie close to the bladder and be isolated by omentum and sigmoid.

Treatment of Adhesions.—Of course the ideal treatment for adhesions is to divide them and cover the denuded area with normal peritoneum, but there are many cases in which this is impossible. The question then arises as to whether any good results from dividing extensive adhesions and not covering the denuded area. This question presents itself most frequently in dealing with adhesions which bury the uterine appendages as a result of salpingitis. If we simply divide them and leave 2 raw surfaces in contact, no doubt we invite a re-formation of adhesions, but, assuming aseptic healing, they will be less dense than the original ones, the result of infection. We do a better service for the patient if, after separating the adhesions, the denuded surfaces are not allowed to come again in contact, i. e. if the denuded area is contacted only with normal peritoneum. To illustrate, if in a case of retroverted uterus the appendages are adherent to the pelvic floor, we first carefully separate them and control active bleeding and oozing. We then suspend the uterus, which elevates the appendages. Afterward, if adhesions form in the culdesac of Douglas, they simply obliterate it and do no harm. The appendages, being brought up to their normal level, with their normal circulation restored and lying in contact only with normal peritoneum, are unlikely to reconstruct adhesions in the absence of infection.

When small intestine is denuded, we have a number of methods of dealing with the defect. If small, sutures are made to approximate its edges provided we do not angulate the gut or but moderately diminish its lumen. When somewhat larger defects occur, we may make use of the omentum. If a separation of a knuckle of gut will produce a very large defect, we may be satisfied to leave the adhesions alone and do a lateral anastomosis between the oral and aboral segments. At times resection will be safer than an attempt to deal with a series of denuded areas distributed along a short segment of gut. Richardson has described 2 methods of utilizing the mesentery to cover defects extending part way around the gut and even for several inches along it. (1) The gut is rotated toward the mesentery of the denuded side and is then stitched to it. This method is employed when the mesentery is thin and contains no fat (Fig. 9). (2) On the side of the denuded area 1 leaf of the mesentery is divided and peeled off from the mesenteric vessels and fat. It is then pulled forward to cover the defect and sutured in place (Figs. 7, 8).

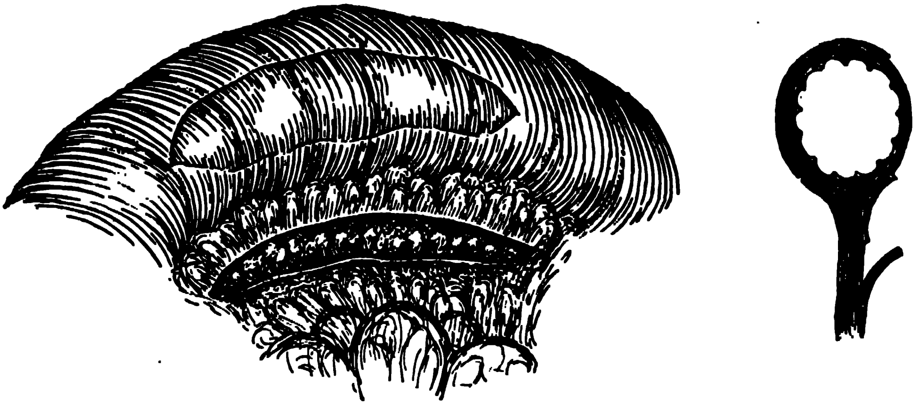
FIG. 7.—RICHARDSON'S OPERATION (1). Mesenteric flap raised.

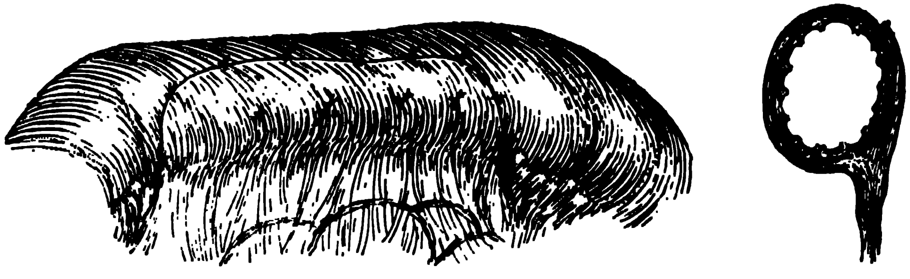
FIG. 8.—RICHARDSON'S OPERATION (2). Flap sutured.

In general we may think of peritoneum as repelling a contact with anything but peritoneum. Foreign bodies, even sutures, produce adhesions, yet numberless efforts have been made to protect from adhesions by covering the prospective adhesive surface by foreign materials, the chief being foreign matters of a mucilaginous or oily character and animal membranes. No great success has followed their use, and they are not advised. Recently the use of camphorated oil has obtained some vogue abroad and is recommended both to prevent infection and adhesions—one wonders how.

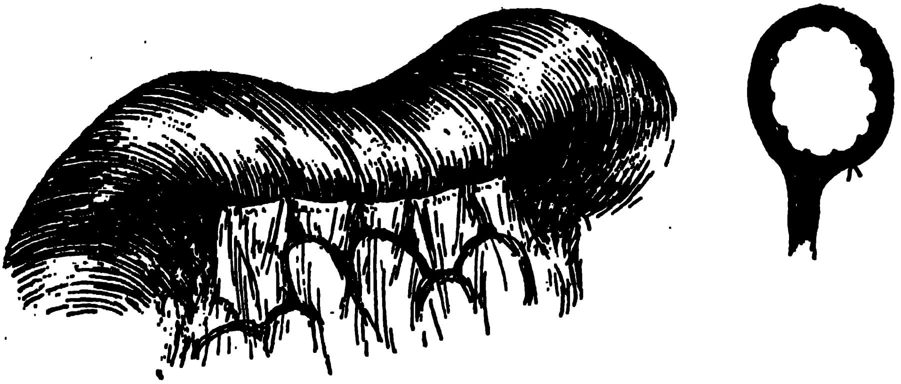

FIG. 9.—RICHARDSON'S OPERATION (3). Gut rotated and sutured to the mesentery.

RETROPERITONEAL CYSTS AND TUMORS

If we exclude the cysts of the kidney, pancreas and parovarium, which are elsewhere considered in this work, the retroperitoneal cysts and tumors will be numbered among the less frequent abdominal swellings, but at the same time they present great variety in origin and structure. Among the benign tumors are lipomata, dermoids, hemorrhagic and other cysts, both unilocular and multilocular. The malignant growths are most often secondary to malignant disease in or out of the abdomen. Sarcoma of the testis is followed by metastatic retroperitoneal tumors. Cancer of the rectum or uterus is followed by retroperitoneal lymphomatous tumors. The primary malignant retroperitoneal tumors are much less frequent than the secondary. The primary ones are either sarcomas or hypernephromas and originate in the renal region. It is not always possible to distinguish between growths having a retroperitoneal and a mesenteric origin, as the retroperitoneal tumors may grow into the mesentery. In the mesentery blood, dermoid and chylous cysts have been described. To illustrate the variety in retroperitoneal tumors those recently seen by me may be mentioned: (a) sarcoma in the mesosigmoid;

(b) a multilocular cyst behind the descending colon and ureter; (c) a fibrosarcoma (Fig. 10) weighing 13 pounds, to the inner side of the ascending colon; (d) a cyst of the tail of the pancreas removed through the lesser sac of the peritoneum; (e) an inoperable hypernephroma, situated on the anterior surface of the lower lumbar vertebræ; (f) a lymphosarcoma behind the cecum.

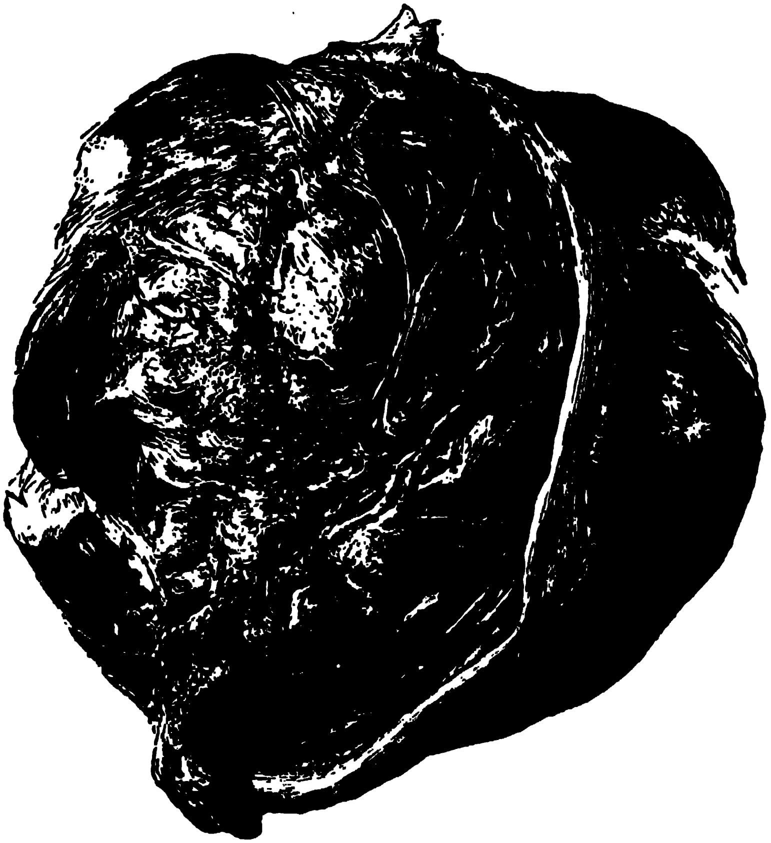

FIG. 10.—RETROPERITONEAL FIBROSARCOMA.

Before operation these tumors and their anatomic relations can scarcely be expected to be diagnosed. The operation will, then, be an exploration, and the first thing to consider is: Shall extirpation of the tumor be attempted? In this decision a good many factors are concerned. The diffuse lipoma is inoperable, though a portion might conceivably be removed to diminish abdominal distention without damage to important structures. Cysts offer the most favorable opportunity for operation. When the cyst is very large and its relations difficult to make out, we may have to be satisfied with removal of part of the sac and marsupialization of the remainder. This is less frequently done now than formerly. Some pancreatic cysts that would formerly have been marsupialized would now be completely enucleated as was the one mentioned above (d).

In treating those cysts that encroach upon the mesentery, a resection of gut may possibly be avoided by care in preserving the blood supply. The cyst, if large, is opened and its wall attacked through the mesenteric leaf that appears the less vascular. Then with the greatest care we shell out the cyst, trying to do so without injury to any arteries or veins, so that there may be no question of the impairment of the intestinal blood supply. This was done in the cyst behind the ureter and descending colon (b). The cyst was removed through the outer layer of the mesentery of the descending colon.

In the large solid fibrosarcoma (Fig. 10), the tumor almost filled the abdomen. It was delivered through an incision a foot long and had the lower ileum stretched over it. The tumor was removed with 3 ft. of the terminal ileum. In dividing the vascular pedicle, a 2 in. rent was made in an extraperitoneal portion of the duodenum. No leakage followed repair. A lateral anastomosis was made between the ileum and transverse colon. The patient is well, 3 years after operation.

With hypernephromata not enclosed by kidney tissue and other malignant retroperitoneal tumors, it will rarely be wise to attempt removal, as the danger from operation will be too great and the prognosis for permanent cure too little to warrant it.

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CHAPTER XI

THE RECTUM

JEROME M. LYNCH

EXAMINATION OF THE RECTUM

In order to arrive at a diagnosis it is necessary, after having taken a complete history, to make a thorough, systematic examination.

Position of Patient.—In order to complete a rectal examination it may be necessary to put the patient in 2 or 3 different positions. The first, and the one usually adopted by most men in this country, is the left Sims'; the second, the knee-chest posture; the third, the lithotomy or exaggerated lithotomy position.

It is nearly always necessary to put the patient in each of these positions before the examination is completed, each one having special advantages over the other for different examinations. The position first assumed is usually the left Sims', as in this attitude a thorough inspection, palpation and digital examination of the anus can be made to the best advantage. This position also allows of palpation of the rectum, and is the most convenient position for a low rectal examination, both from the point of view of the patient and the surgeon.

For a proctoscopic or sigmoidoscopic examination the knee-chest posture is the most convenient.

The lithotomy position is the most convenient for rectal operations; also for bimanual examination of the rectum and sigmoid, and especially for exploration of the rectum after the method of Simon.

The exaggerated lithotomy position is sometimes more advantageous than the knee-chest posture for proctoscopic examinations. Many times when it is impossible to pass the proctoscope in the knee-chest posture it can be easily and conveniently passed in the exaggerated lithotomy pose.

Preparation of the Patient for Examination.—Physicians are frequently at sea as to the proper toilet of a patient before examination. Many believe that a patient should be thoroughly irrigated and all fecal matter removed before a rectal examination. This is a mistake, since it is only by examining patients under every-day conditions that we can judge of the state of the intestines and see things exactly as they are. For this reason it is better that the patient should not make any preparation until after the first examination. It may be necessary after this to order an enema or a laxative, in order to explore the rectum and sigmoid thoroughly, but for the first examination the patient should be in his usual condition.

Inspection.—With the patient in the Sims' position, careful inspection of the anus will furnish a great deal of information. The relaxed and prolapsed perineum, with slight protrusion of the anal mucous membrane and loss of peri-anal fat, so typical of tabes dorsalis, can immediately be noted. So typical is this of tabes, that more than once I have been able to make a diagnosis of tabes from this picture, subsequently verified by the usual examination. In tuberculous patients loss of fat, with retracted anus, prominent tuber ischii, lanugo hairs and the pinkish skin so typical of the disease can be seen at a glance. Also one can note the condition of the skin, whether it is thickened and thrown into folds, lacerated or dry, or covered with the abrasions so typical of pruritus ani. If there is a fistulous opening, it, too, should be easily discovered. Fissures, hemorrhoids, pediculi and pin worms will all be easily seen. The condition of the sphincter can be noted, whether it is normal, relaxed, or spasmodic; whether there is any evidence of inflammation from abscess or of thrombotic hemorrhoids.

After these points have been observed, the patient should be asked to bear down, and, at the same time, by separating the buttocks, the condition of the anal canal can be observed.

This procedure is often all that is necessary to make a diagnosis in cases of fissure, hemorrhoids, fistula, hypertrophied papillæ, polypus, and partial or complete prolapse of the rectum.

Palpation.—Much can be learned from palpation, as, for instance, the presence of an abscess or fistula, the location of a fissure, or the presence of a tumor in the lower rectum. This method of examination is particularly useful for determining the condition of the sphincter, where a digital examination is impossible except under anesthesia.

Digital Examination.—This is the most satisfactory method of rectal examination, and gives us more information than any other similar procedure, especially where the tactile sensation is well developed. To those familiar with this method of examination, even a slight abrasion of the mucous membrane can be detected. Simple as it may seem, it requires some understanding of the proper method of introducing the finger. If one is very gentle, he can make this examination with a minimum of pain, and it is sometimes possible, even in the most painful conditions, to introduce the finger and make an examination with very little inconvenience to the patient.

Before introducing the finger, the nail should be covered with castile soap to prevent injury to the mucous membrane during the examination. Under ordinary conditions, covering the index finger with a finger cot is perhaps the safest, both from the point of view of the patient and the surgeon; but with some men the finger cot is apt to blur the tactile sensation, so that it cannot always be used.

The finger, having been lubricated, is passed into the rectum by a gentle boring motion, but always away from the painful spot. After the finger has been introduced, it is gently swept around the rectum, and the condition of the prostate is noted; in the female, if the cervix uteri is retroverted or enlarged, and if it presses on the rectum, it can be felt at this time.

We mention this because, more than once, the cervix, when felt through the rectum, has been mistaken for a new growth or a stricture. If the uterus is retroverted or retroflexed, or both, this can also be noted, as can tenderness around the region of the tubes or ovaries. It is much safer, in the majority of cases with the female, to make a subsequent vaginal examination, noting the condition of the genital organs and their relationship to the rectum. This is not always possible, and the rectal examination may be sufficient, especially in the case of virgins.

A digital examination is generally sufficient to determine the presence of a stricture, new growth, whether benign or malignant, enlarged prostate, abscess of the prostate, superior or posterior pelvirectal abscess, and any other abnormality within reach. As the finger is withdrawn, any deviation from the normal is noted, such as the internal opening of a fistula, submucous or deep abscesses, hypertrophied papillæ, polypi, fissure, sensitive crypts, the tone of both sphincters, suburethral abscess, and, in the female, the presence of a rectocele.

Introduction of the Hand for Purposes of Diagnosis.—The method first exploited by Simon of Heidelberg, who introduced the entire hand into the rectum in order to definitely determine the presence or absence of a tumor and, in fact, to explore the abdomen, is of inestimable value when properly carried out under general anesthesia, but it should never be practiced by any surgeon the circumference of whose fist is greater than 9½ in. There is always danger of shock in this operation, and for this reason the patient should be constantly under the observation of the surgeon, so that in case of pronounced shock, the examination can be immediately discontinued.

Instrumental Examination.—We are indebted to the following gentlemen for the development of the proctoscope: Bowdenheimer, Marion Sims, Van Buren, Howard Kelly, Beach, Pennington, Laws, and Tuttle.

Many modifications of the original proctoscope have been made. I prefer the Tuttle proctoscope for some examinations, and my own proctoscope for general examination. The following objections have been offered to the Tuttle proctoscope: (1) That it cannot be boiled; (2) that the lamps are easily burned out; (3) that the water gets into the auxiliary tube, resulting in a short-circuit. These objections can be readily answered. The Tuttle instrument is delicately balanced and requires some gentleness in handling. If, after boiling, any water remains in the auxiliary tube, it can easily be removed by means of a piece of cotton on the end of an applicator provided for that purpose.

The second objection can be overcome if ordinary precaution is exercised before turning on the current. The current should be turned into the lamp on the rheostat and then gradually back into the second volt lamp on the end of the carrier, until a sufficient amount of light is obtained.

My own instrument consists of a plain tube 12 in. long and 1½ in. in diameter.

Beside the instruments enumerated, there are several others on the market of various sizes and caliber. All were devised with the idea of suiting some particular case, but the Tuttle instrument and my own are sufficient for all practical purposes. A very small proctoscope is used in cases of tubular strictures, as it is very often important to determine how far up the stricture extends, and to ascertain the condition of the mucous membrane above the stricture.

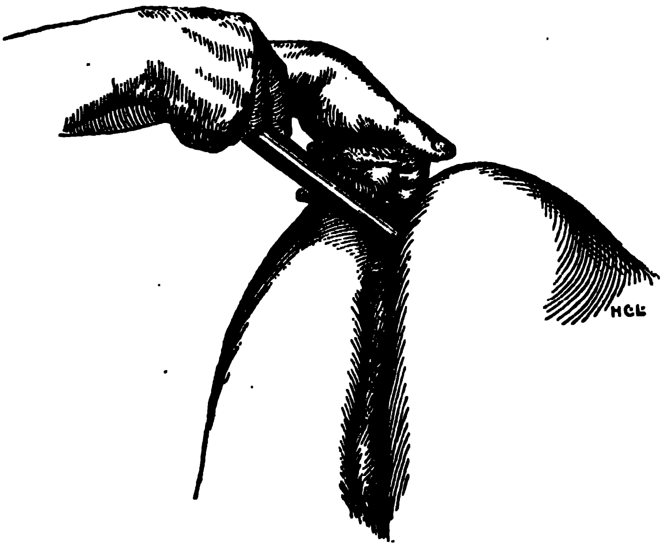

Fig. 1.—Lynch Method of Introducing the Proctoscope.

When passing the proctoscope the instrument should be held in the following manner: The auxiliary tube uppermost; the handle of the obturator pressing against the ball of the thumb; the flange of the proctoscope held between the thumb, index, and middle fingers, as illustrated (Fig. 1). The object of allowing the handle of the obturator to rest against the thumb is to prevent the slipping out of the obturator when the instrument is being passed.

The tip of the instrument is now well lubricated with some lubricant, such as we have already mentioned; the left index finger is also lubricated; the patient is placed in the knee-chest position on the table; the left index finger is introduced into the rectum; the patient is asked to bear down, and the proctoscope is passed, the tip of the obturator resting on the inner surface of the left index finger (Fig. 1). As the instrument is passed in, the auxiliary tube continues to press on this index finger, and as the instrument passes in, the finger is gradually withdrawn.

The instrument having passed inside the internal sphincter, connections are made between the light carrier and the rheostat. After the light has been turned on, the obturator is withdrawn. The instrument is now passed entirely by sight and it is not at all necessary, with a good light, to allow the instrument to injure the membrane in any way. The plug and glass window closing the end of the tube, to which an inflating apparatus is attached, can be brought into requisition, and the rectum and sigmoid dilated with air, when the tube can be easily passed. When the rectosigmoidal junction is reached, the sigmoid, which adjoins the rectum, turns either to the right or left—in our experience, more frequently to the right. At this point difficulty is at times encountered, even by the most experienced, and if great care is not exercised it is quite possible to do material damage.

I have, on more than one occasion, seen cases of supposed stricture, where the surgeon had failed to pass the proctoscope, and found that by a little manipulation I could pass it without difficulty. The reason of this is that, where the sigmoid joins the rectum, it forms an acute angle, and over this one of Houston's valves has fallen, obscuring the direction of the gut from the surgeon. No force should be used here. We say this because we know men who have tried to force the proctoscope at this point, imagining that there was some collapse of the bowel which could be passed without trouble, with the result that the mucous membrane has been seriously damaged. I have seen a swelling of the mucous membrane where it has been pressed against the sacrum by the proctoscope in the endeavor of the surgeon to pass the instrument. This is not necessary. A little manipulation, passing the instrument from side to side, asking the patient to take a deep breath and inflating occasionally, will reveal the direction of the canal. If a spasmodic condition of O'Byrne's sphincter exists, by waiting until the spasm subsides, the instrument can be passed into the sigmoid with the greatest ease. How far the instrument can be passed when it has entered the sigmoid depends entirely upon the length of this portion of the bowel. At no time, except where the mesentery of the sigmoid is very short and where very little sigmoid exists, can the instrument be passed above the apex of the sigmoid. If the instrument continues to pass after this, it is because the sigmoid and mesosigmoid are very long and this portion of the bowel is pushed before the instrument until, in some cases, it almost reaches the diaphragm.

If the patient is put on his back when the instrument has been passed in, and after the obturator has been replaced in the instrument, the tip of the obturator can be felt through the abdominal wall. Some physicians imagine, under these circumstances, that they have passed the instrument into the descending colon, but such is not the case. A good idea of the length of the sigmoid can be obtained when the instrument is in this position. The mobility of the sigmoid can also be determined by moving the instrument from side to side. In a perfectly healthy sigmoid, where no adhesions exist, it is possible to make a complete half-circle from right to left. If adhesions exist, it is easy to determine the point where the sigmoid is bound down, because the obturator will indicate the exact position.

I must digress for a moment to point out the liability of mistaking the mesosigmoid, or a sigmoid with a very short mesentery, for an adhesion or *angulation of this organ. With mesosigmoiditis the mesentery is thickened and the instrument cannot be moved from side to side.* Now, if the sigmoid runs in the direction of the cecum, it is quite possible to get the instrument as far as that organ and, not being able to move it toward the left, one is apt to arrive at the conclusion that adhesions exist between the sigmoid and the cecum. Therefore, great caution should be exercised and a thorough examination made of the sacral region; if necessary, an X-ray photograph of the sigmoid and cecum can be obtained, which will clear up the diagnosis.

The rest of the sigmoid, not reached by the sigmoidoscope, can be outlined by passing a tube which I have devised, namely, the sigmoidodiaphrame, through the sigmoidoscope into the ascending limb of the sigmoid and connecting the tube with the rheostat. By transillumination the rest of the sigmoid can be outlined.

To those familiar with the use of the proctoscope or sigmoidoscope the slightest abnormality and all gradations between the physiologic and pathologic can be determined—catarrhal conditions, hypertrophy of the valves of Houston, ulceration, strictures, new growths, angulations, etc.

Before the instrument is withdrawn, the obturator should be inserted, as otherwise the sphincter grasp on the end of the tube may cause considerable trouble.

MALFORMATIONS OF THE RECTUM

Embryonic Development of the Foregut.—About the end of the third week in the embryo an anterior projection, or budding, of the yolk sac can be appreciated. This goes later to form the foregut and, with that portion of the future intestine anterior to a line drawn through the middle of the yolk sac, forms the entire small intestine, pharynx, esophagus, stomach, and duodenum. Embryos have been examined at such an early stage that there was no evidence of the foregut or hind-gut, but the allantois was present as a budding or projection from the yolk sac, showing that the allantois is formed at a very early stage, and before the hind-gut. It is believed by Mall and others that as the diverticulum, or budding of the hind-gut grows down, it carries with it the allantois until both reach that bay at the caudal end of the embryo which is known as the cloaca.

The intestine now gradually develops, and the changes that take place are of interest because of the persistence of embryonic features which may later require surgical measures for their correction. That portion of the intestine which is described by some embryologists as the mid-gut is suspended from the roof of the yolk sac (Fig. 2). The neck of the yolk sac elongates and narrows. The portion of the intestine known as the U-shaped tube is really outside of the abdominal cavity at this period. This is explained by Mall as being due to the rapid growth of the liver, which forces the bowel outside of the abdominal cavity. As the yolk sac becomes smaller, the intestine retrogresses into the abdominal cavity, covered by the somatopleure. The vitelline artery afterward becomes the superior mesenteric, which is the artery of the U-shaped tube (Fig. 2). Between the end of the first month and the beginning of the second a diverticulum, or outgrowth, appears on the border of the posterior limb of the U-shaped tube. This diverticulum represents the future cecum and appendix. At this period the cecum and the large intestine are of about the same caliber as the small intestine, and it is not until the fifth month that the cecum becomes appreciably larger than the small intestine. The appendix, which has retained its

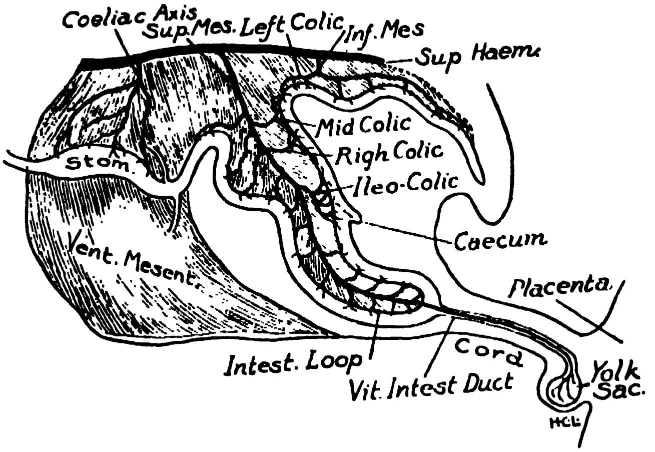

FIG. 2.—THE ALIMENTARY CANAL ABOUT THE FIFTH WEEK OF FETAL LIFE. The very interesting point is also illustrated that at this period the large bowel is very much smaller than the small bowel.

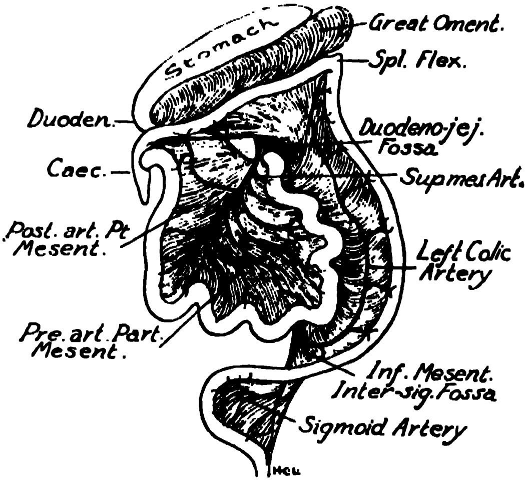

FIG. 3.—THE POSITION OF THE COLON AFTER ROTATION. Notice the funnel-shaped appearance of cecum and appendix.

embryonic character, is the terminal portion of the cecum. In other words, the future appendix does not keep pace with the growth of the cecum, but retains its embryonic size.

As the small intestine continues to grow, a change takes place in the posterior loop of the U-shaped tube. The portion of the bowel aboral to Meckel's diverticulum rotates around to the left, so that the cecum comes into a position in front of the duodenum (Fig. 3).

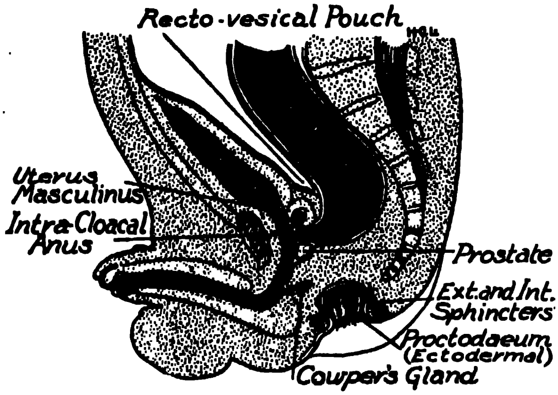

FIG. 4.—IMPERFORATED ANUS WITH AN OPENING INTO THE PROSTATIC URETHRA.

Modern embryologists divide the alimentary canal into the hind-gut and foregut. All the bowel in front of the vitelline intestinal duct is known as the foregut; all back of that is known as the hind-gut. Meckel's diverticulum is formed by the persistence of the vitello-intestinal duct.

Embryonic Development of the Hind-gut.—The hind-gut may be arrested at any point between the vitello-intestinal duct and the anus. There are cases on record where the entire hind-gut was absent, and where, at the same time, the vitelline duct remained patent and the contents of the bowel were emptied through this opening at the umbilicus.

As a result of a double budding we may have the double hind-gut. It may be a single tube separated by a septum, or there may be 2 distinct tubes on 1 mesentery.

The hind-gut may maintain its connection with the allantois, from which the bladder is frequently formed. In such a case the hind-gut would open into the bladder and the fecal matter empty through the urethra. There is a case on record where the urachus remained patent and the hind-gut emptied into the bladder and the fecal matter passed through the urachus and emptied at the umbilicus.

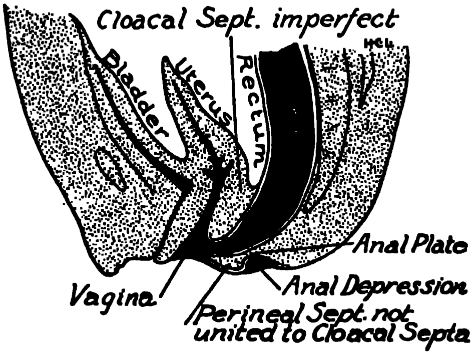

FIG. 5.—RECTOVAGINAL OPENING SHOWING IMPERFORATE RECTOVAGINAL SEPTUM AND PERFORATE ANUS.

The hind-gut may open into the posterior urethra (Fig. 4). This is the result of imperfect union between the cloacal septum and the perineal septum. Imperfect union between the cloacal septum and the perineal septum in the female results in an opening between the vagina and the rectum (Fig. 5). As a result of an imperfect formation of the perineal septum we may have an opening into the anterior urethra or the vulva in the female.

After the rectum has reached the perineal depression, it is separated from the anus by a thin membrane. This membrane usually is broken down about the third month. Sometimes it may become invaded by a connecting tissue and give rise to the condition known as imperforate anus (Fig. 6). Sometimes this septum between the anus and the rectum partially breaks down, resulting in a partial stricture.

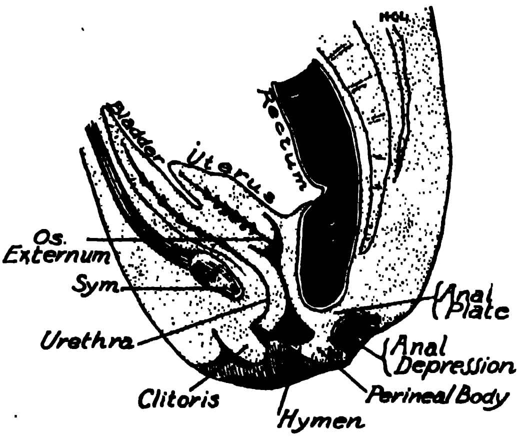

Fig. 6.—Imperforate Anus.

Treatment.—There are a few general principles to be observed in the treatment of abnormalities of the bowel and anus, which, if adhered to, will offer the best solution of the treatment which should be instituted when such cases come under our observation.

If there is an outlet, even though it be through some other organ, or at a point distant from the anus, it is better to wait until the child is older than to resort to surgery, provided the life of the child is not threatened by the bowel opening into some vital organ, such as the bladder, a condition which would undoubtedly result in the death of the child from an ascending infection. If such a condition exists, colostomy is indicated, and this can usually be performed under local anesthesia.

If the anus is well formed, and only separated from the hind-gut by thin membrane, the membrane can readily be broken down and connection established between the anus and rectum. If there is some doubt as to the distance between the anus and the hind-gut, as occasionally happens, it is very much safer to make an artificial anus rather than perform an extensive operation with the object of locating the hind-gut and bringing it down to the anus.

FISSURE OF THE ANUS

A fissure is a solution of the continuity of the mucous membrane (Fig. 7).

Symptoms.—Burning pain, lasting anywhere from 15 minutes to several hours, follows movement of the bowels. A few drops of blood are frequently noted after a movement. On account of the fact that the long pudendal nerve supplies the sphincter and the compressor muscles of the urethra, painful urination is usually associated with anal fissure. Many times the pain is associated with urinary trouble rather than with rectal trouble in the mind of the patient. Tuttle relates an instance of a man who had been treated for many years for stricture of the urethra before coming under his observation. On examining the patient he found a fissure in the posterior commissure, and after the fissure was appropriately treated, the man's original symptoms disappeared.

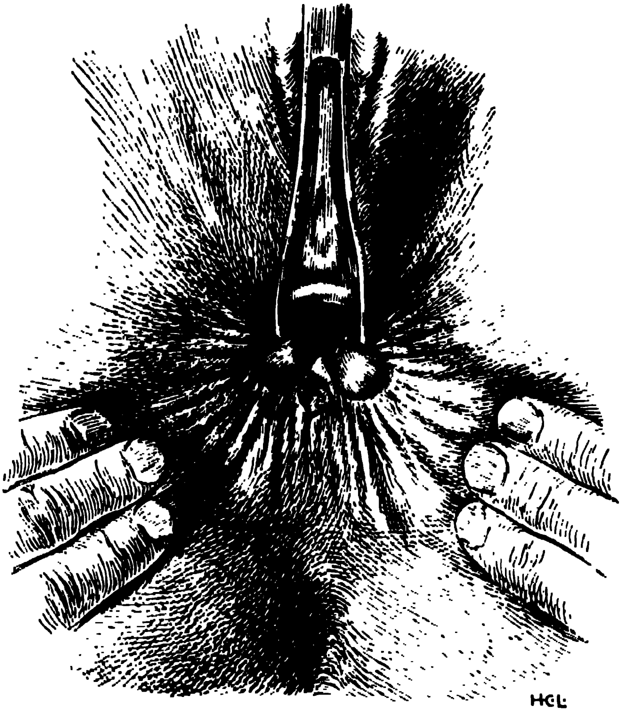

FIG. 7.—PATIENT WITH A FISSURE, HEMORRHOIDS AND AN INFLAMED PAPILLA. Drawing made before operation.

Other reflex symptoms are pain along the sciatic nerve, pain in the back, and constipation.

Local Treatment.—When a fissure is recent and drainage is fairly good, applications of ichthyol or nitrate of silver sometimes afford the most gratifying results. The ichthyol is applied in the following manner: A little cotton is wrapped around the end of a wooden applicator and dipped in pure ichthyol. The patient is instructed to bear down, where the fissure will generally come into view. Ichthyol should then be applied directly to the raw surface. Sometimes it is necessary to use some local anesthetic before making any application, as the muscle is spasmodically contracted, and the application of anything is so painful that it is impossible, without some anesthetic, to accomplish anything. The following procedure should then be adopted:

About 10 minims of a 2 per cent. solution of novocain, or hemesia, is injected just under the fissure. After this has taken effect it will be comparatively easy, in some cases, to pass the speculum and directly apply the silver or ichthyol to the fissure. The anesthetic effects of the hemesia are more lasting than those of cocain.

This procedure should be instituted every other day until the fissure is healed. When the fissure has existed for a long time, and local applications fail to relieve it, surgery is obviously the only alternative.

Surgical Treatment.—INDICATIONS.—Imperfect drainage, chronicity of the lesion, and failure of local treatment are indications for surgical treatment.

DIVULSION.—The indications for divulsion are failure of local treatment. Divulsion is followed by extravasation of blood, resulting in injury to the muscle, which may be followed by infection and incontinence. A general anesthetic is required.

INSTRUMENT USED IN DIVULSION.—The instrument used in divulsion is a Sims speculum; but the operation can be carried out without any instrument by using the thumb of the right and left hand.

ANESTHESIA.—This operation can be performed under local or general anesthesia. When local anesthesia is used, the needle should be introduced about ½ in. back of the posterior commissure, and the skin and tissues beneath, up to the internal sphincter, anesthetized. After this, the needle is gradually worked around to one side of the sphincter nerve, advancing beyond the anesthetized area until the novocain—or whatever anesthetic is used—is deposited. In this way the sphincter on both sides is anesthetized. After this has been accomplished the edges of the ulcer should also be anesthetized and trimmed off with the scissors. Finally the muscle is divided posteriorly, to establish drainage and to put the muscle temporarily at rest.

To dilate the sphincter while the patient is in the first or second stage of anesthesia is apt to result seriously on account of the reflex deep inspiration which follows stretching of the muscle.

METHODS OF STRETCHING.—There are several methods of stretching the sphincter. *First Method:* With the patient in the lithotomy or Sims' position (it is taken for granted that the operator wears rubber gloves) the left thumb is thoroughly lubricated and gradually introduced into the rectum. The sphincter is gently dilated, pressure being made toward the posterior commissure. The second thumb is now introduced and, with both thumbs in the rectum, the sphincter is dilated or divulsed.

Second Method: A Sims' speculum should be introduced into the posterior quadrant. After the speculum has been introduced by gradual backward pressure the muscle is dilated.

Third Method: With the hand forming a cone, the apex of the cone being the fingers, the hand is gradually introduced into the rectum and dilatation or divulsion is accomplished in this manner.

Dangers and Difficulties.—Injury to the prostate is a real danger in dilatation of the sphincter, if one is not very careful. The speculum should never be introduced anteriorly for the purpose of dilating the muscle, as serious injury to the prostate may result from such a method. Abscesses have been known to follow when such procedure has been carried out.

The second danger is overstretching, and this may result in temporary or permanent incontinence.

The third danger is that of rupturing some muscular fibers, with hemorrhage into the muscular tissue, which is apt to be followed by canalization of the blood and connective tissue, changes resulting in permanent destruction of the muscular fibers.

ABSCESSES OF THE RECTUM AND ANUS

Abscesses of the rectum and anus may be divided into 2 classes: superficial and deep. The superficial are those that occur under the mucous membrane and abscesses of the triangular space.

SUPERFICIAL ABSCESSES

Symptoms.—The symptoms accompanying superficial abscesses are insignificant at first. When the abscesses are fairly well developed, the patient experiences discomfort in sitting and walking and from the rubbing of the clothing. If the abscess is in the triangular space, there is usually tenesmus, with severe pain when the bowels move. There is very seldom any temperature as a result of abscesses in this region. An abscess nearly always requires some surgical procedure for its correction.

Instruments Used.—The instruments used in operating for superficial abscesses are a knife, a dissecting forceps, a cautery, scissors, and 2 or 3 artery forceps.

Operative Technic.—The majority of superficial abscesses can be opened under local anesthesia. I prefer hemesia, and the technic of introducing the anesthetic is very important. It should be introduced in the following manner:

A little ethyl chlorid is sprayed on the skin about ¼ in. from the abscess, and the needle is introduced into the skin at this point, the object being to prevent the pain which results from the introduction of any local anesthetic in the inflamed region of the abscess. The skin between the point of introduction and the abscess is slowly and carefully anesthetized. By the time the abscess is reached, the patient will have become accustomed to the slight pressure from the introduction of the anesthetic, so that the area over the abscess cavity can be anesthetized with very little discomfort. If it is deemed necessary to open the abscess cavity by the crucial incision, the area of incision should be anesthetized in the same manner as has been described. With hemesia we have very little difficulty in opening tuberculous abscesses with the actual

cautery, as a general systemic infection may result from the use of the knife. Such cases have been reported.

Causes of Failure.—Imperfect drainage, resulting from a small incision, is the most frequent cause of failure.

Complications.—Systemic infection, especially in tuberculous cases, is a complication to be avoided. Injury to the mucous membrane may result in a fistula, and a fistula resulting from imperfect drainage follows in a certain percentage of cases.

Results.—Results are usually good, the abscess healing in 3 to 4 weeks.

ISCHIORECTAL ABSCESS

Symptoms.—In this form of abscess the symptoms are usually quite marked, and are as follows: Slight chill, very high fever, 104° to 105°, headache, and severe pain during sitting, standing, or while lying on the affected side. There may or may not be urinary symptoms, such as difficulty in urination. Owing to spasm, there may be complete retention, and in some cases it is necessary to catheterize in order to afford the patient relief. As these abscesses, in a large percentage of cases, originate from a fissure in the posterior commissure, they make defecation exceedingly painful. In fact, any movement that causes the patient to elevate the rectum, or to move the levator ani muscle, results in pain.

The skin surrounding the fossa is usually very red and indurated; the inflammation, redness and induration, in some cases, being out of proportion to the amount of pus in the cavity. In many cases the patient is extremely septic, and these abscesses have been known to terminate fatally. As I mentioned before, abscesses in the ischiorectal fossa often originate from an ulcer in the posterior commissure, the infection traveling through the triangular space into the ischiorectal fossa on one side and frequently infecting the other. This seems to be the opinion of many surgeons. I have seen many cases of ischiorectal abscesses, but have never witnessed this phenomenon. I have, however, seen a horseshoe fistula, with a common communication posteriorly, the sidetracks communicating with the ischiorectal fossa (Fig. 8). It is, therefore, fair to assume that this fistula must have resulted from an infection of both fossæ.

Indications for Operation.—The moment any evidence of pus formation is discovered, early resort to surgery should be had. Palliative measures are entirely out of place and the theory of some physicians that an abscess should not be opened until it bursts is archaic. An abscess in this region demands immediate surgical attention, and even a simple incision, though no pus be found, will result in an early disappearance of all symptoms.

Anatomical Points to Be Noted.—The anatomical points to be noted in connection with ischiorectal abscesses are the presence of loose cellular tissue, *blood-vessels, and nerves running through* this cavity. The ischiorectal fossa is a triangular space, the apex of which is formed by the union of the obturator fascia with the lower fascia of the levator muscle (Fig. 9). The base is formed by the skin, superficial fascia and the loose tissue between the anus and the tuber ischium. An abscess in this region, if not treated surgically, usually finds an exit between the 2 sphincters in the posterior commissure. Occasionally it ruptures through the levator ani and then through the rectum.

Operative Technic.—It is important to realize that pus may be pocketed; in other words, there may be a number of little abscesses, and it is necessary that these abscesses should be opened up. This is best accomplished with a gloved finger after the cavity has been incised. Anyone who has had experience can easily distinguish between healthy and necrotic tissue, and the surgeon should not break down or destroy tissue that is apparently healthy. The destruction of tissue and opening into blood-vessels are contra-indicated, do not accomplish anything, and are likely to be followed by infection in other regions adjacent to, or distant from, the original focus. When both ischiorectal fossæ are involved, some doubt may exist as to the best method of procedure. Hartman, under these circumstances, does not believe in opening both abscesses. He prefers to open posteriorly at a point where both abscesses communicate. This is usually at the apex of the triangular space. From this point he inserts drainage tubes into both abscess cavities. There seems no good reason for following this procedure. It would seem better to drain thoroughly both abscess cavities at the same time and, after the pus has thoroughly drained, to treat the fistula, which must necessarily follow, at a subsequent sitting. As we have said, patients with infection in this region are ordinarily very septic and the sooner all pus is evacuated and thorough drainage established, the sooner the patients will recover from this sepsis.

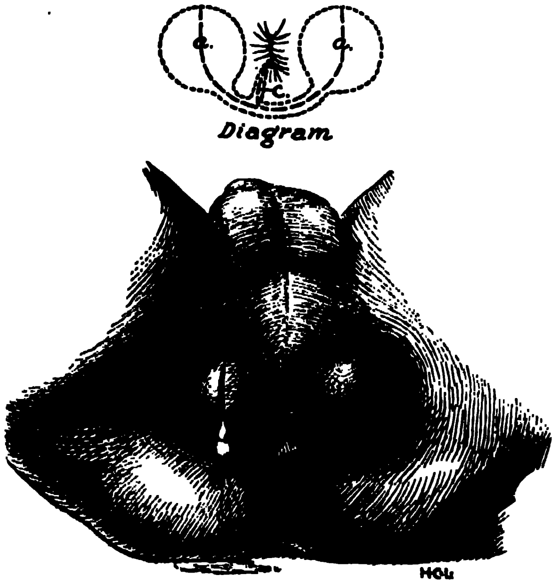

FIG. 8.—DUMB-BELL ABSCESS WITH OPENING INTO THE POSTERIOR COMMISSURE.

Instruments Used.—The instruments to be used are a knife, scissors, thumb forceps, dressing forceps, ½ dozen artery clamps (Kocher type), drainage tubes, and 2 retractors.

Dangers and Difficulties.—There is no difficulty in opening an ischiorectal abscess. There is some danger of destroying the branches of the long pudendal nerve and of opening into the healthy tissue, thereby disseminating the infection; and there is always danger, in the hands of the inexperienced, of doing too much.

Causes of Failure.—Failure to cure an ischiorectal abscess is due, in a majority of cases, to imperfect drainage or anxiety on the part of the surgeon for fear the cavity will not be properly drained. As a result the drainage tube is left in place too long, resulting in a fistula. In a great many cases failure is due to over-treatment.

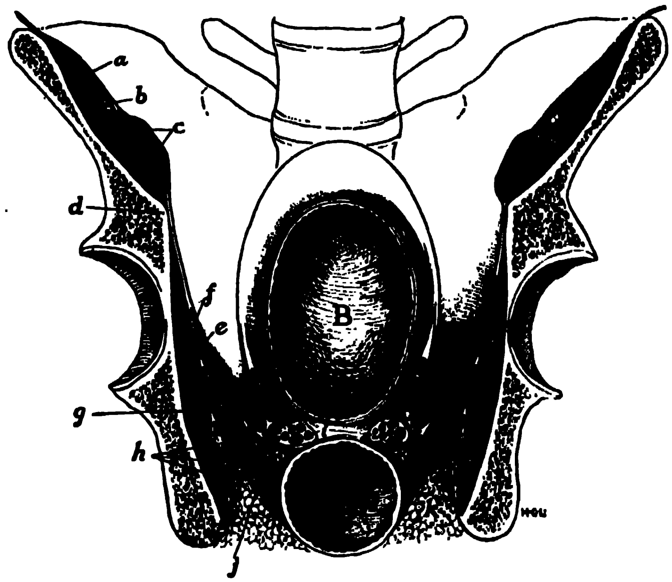

FIG. 9.—THE DISTRIBUTION OF THE PELVIC FASCIA. a, Iliac fascia; b, femoral nerve; c, iliac vessels; d, pelvic brim; e, rectovesical fascia; f, posterior fascia; g, anal fascia; h, internal pudic vessels and nerve; j, levator ani muscle; k, ischiorectal fascia.

Another cause of failure is the lack of appreciation, on the part of the surgeon, of the communicating tract, of the fact that the abscess cavity may have ruptured into the rectum high up, and of the fact that in many cases the original opening is in the posterior commissure and may be very small. But it is always the duty of the surgeon to search very carefully for any opening in this region. Failure to recognize this is almost certain to result disastrously.

After-treatment.—The after-treatment of ischiorectal abscesses consists in a watchful supervision. The drainage tube, if one is used, should be removed at the end of 48 hours and should not again be inserted unless some unusual condition arises, such as the formation of a deep pocket at the apex of the space. After the drainage tube has been removed, the abscess cavity is very lightly packed with gauze, bismuth gauze being preferred. After the third *or fourth dressing the wound should be allowed to come together on the inside. The gauze packing should be confined to the outside incision to prevent* healing on the outside before the cavity has thoroughly granulated on the inside.

If the lines we have laid down are followed, nearly all ischiorectal abscesses will heal, provided there is no connection with the rectum. When such a communication exists, and has been overlooked, a fistula will result; until this is cured success will not be attained.

POSTERIOR PELVIRECTAL ABSCESS

The posterior pelvirectal abscess is situated between the rectum and the sacrum. This abscess may follow a superior pelvirectal abscess or the infection may be primarily in the posterior pelvirectal space. It should always be borne in mind, when treating a posterior pelvirectal abscess, that a communication may exist with the superior pelvirectal space, so that the proper procedure may be followed to establish drainage of both cavities.

Symptoms.—The symptoms of posterior pelvirectal abscess may be very indefinite. Many abscesses are quite well developed before there are any really well pronounced symptoms. The first indication may be a sense of weight over the sacrum, with slight indisposition, chilly sensations, and other slight symptoms, which may suggest an infection but not point to anything definite. As a general rule, however, abscesses of this region, as in other parts of the body, are first indicated by a chill, followed by a rise of temperature, headache, and similar symptoms of infection.

Indications for Operation.—The indications for operation are an evidence of infection, with a mass back of the rectum, tenesmus, and bearing down, with a feeling of unfinished stool. The abscess may burrow up into the loose connective tissue just above the culdesac, or it may burrow, as in the former abscess, push the peritoneum before it, and point at the inguinal region.

Anatomical Points to Be Noted.—That portion of the rectum between the peritoneal reflection and the levator ani muscle is divided into 2 spaces of great surgical importance, where important blood-vessels and lymphatics ramify. Abscesses forming in these spaces, if not recognized early and treated properly, may result in permanent injury or death. The rectum between the peritoneum and the levator ani muscle is surrounded by a layer of fascia and loose cellular tissue. The layers which run from the pelvis to the side of the rectum are known as the lateral ligaments of the rectum. They contain the middle hemorrhoidal arteries and separate the anterior from the posterior pelvirectal space. The anterior space is bounded above by the peritoneum, below by the levator muscle and its fascia, anteriorly by the urethra, prostate and base of the bladder; posteriorly by the rectum and the lateral ligaments. This space is of much surgical interest, because abscesses of the prostate frequently rupture here, and on the proper surgical treatment will depend the future comfort of the patient.

The roof of the abscess is formed by the rectum in proximity to the peritoneum.

Instruments Used.—A knife, scissors, thumb forceps, dressing forceps, ½ dozen artery clamps (Kocher type), drainage tubes, and 2 retractors are needed.

Dangers and Difficulties.—The dangers are injury to the adjacent organs, perforation of the peritoneum, peritonitis, and hernia of the small intestine.

Technic of Operation.—The abscess should be opened at the most dependent point, which is about the sacrococcygeal junction, or an inch posterior to the sacrococcygeal joint. The incision is made at the tip of the coccyx to one side or the other and extended back to and beyond the sacrococcygeal joint. With the gloved finger all trabeculæ are broken, the cavity is washed out with saline, a drainage tube is inserted, and round this is packed some bismuth or iodoform gauze. At the end of 48 hours the packing is removed and also the drainage tube. The cavity is washed out with salt solution. The drainage tube is again inserted and a little gauze packed around it. At the end of the third day the drainage tube is finally removed and not inserted again unless there is some indication, such as pocketing or imperfect drainage. After removal of the tube the wound is carefully watched to see that pocketing does not occur; and after the first week all that is necessary is to keep the wound clean and prevent it from healing at the outlet before the cavity has filled in. It is sometimes necessary to use Beck's paste to complete the healing of the cavity.

SUPERIOR AND POSTERIOR PELVIRECTAL ABSCESS

Symptoms.—The immediate recognition of abscesses in these spaces is of the greatest importance to the patient, on account of the proximity to the peritoneum, bladder, prostate, and urethra. If they are opened early, and skillfully handled, the most brilliant results follow. The superior pelvirectal space is that space bounded above by the peritoneum and below by the levator ani muscle and its fascia; anteriorly by the trigone of the bladder, prostate, and urethra; posteriorly by the rectum and its lateral ligaments. The blood supply is usually from the hypogastric artery; the lymphatics originate around the prostate and neck of the bladder in the male and the uterus in the female. As a general rule, the first symptom noticed by the patient is a feeling of weight in the rectum, and a bearing down when the bowels move. This may or may not be preceded by a chill and rise of temperature, as a large percentage of abscesses of this region are due to infection from the prostate, seminal vesicles and posterior urethra. A previous history of gonorrheal infection, followed by a retention of urine, and then frequent urination, very often precedes *abscess in the superior pelvirectal space and so masks the symptoms as to allay suspicion of the real condition. In women these abscesses are very often mistaken for a tubo-ovarian infection.* In one case recently under my observation, the patient had a distinct chill, followed by a temperature of 104° and evidence of profound sepsis.

A digital examination will reveal a mass bulging into the vagina, or, if rectal examination is made, the mass can be identified in the rectum.

Indications for Operation.—The first evidence of induration, swelling, or fluctuation between the rectum and vagina in the female should be sufficient to warrant a consideration of surgical measures. Differential count, with a marked leukocytosis (over 30,000), is confirmatory of the presence of pus.

Anatomical Points to Be Noted.—The proximity of the urethra, prostate, bladder, and rectum in the male, and of the vagina in the female, requires the surgeon to be on his guard lest by any chance he perforate any one of the adherent organs.

Instruments Used.—A knife, scissors, thumb forceps, dressing forceps, ½ dozen artery clamps (Kocher type), drainage tubes, and 2 retractors are needed.

Dangers and Difficulties.—There is always the danger of injuring any of the organs mentioned.

Technic of Operation.—It is exceedingly important that an abscess in the superior pelvirectal space should be properly opened. Serious complications may follow improper opening, and the life of the patient may be threatened. If the abscess is opened through the rectum, as has happened occasionally, such cases having come under my observation, a very grave situation may be created. I have previously mentioned the fact that a large percentage of the abscesses in this region are due to infection from the prostate and urethra or uterus and broad ligaments. Assuming that the abscess originates from the urethra or prostate, if by any chance it should open into the rectum, or, by improper treatment, into the rectum and urethra, rectal fistula would result, a form of fistula extremely difficult to handle. Since very few men have succeeded in curing these fistulæ, the proper method of opening such an abscess is of greatest importance.

The abscess should be opened through the perineum by a transverse incision, dissecting between the urethra and rectum in the male, and the vagina in the female. The levator ani muscle is cut transversely; the muscular fibers thus have a tendency to pull apart, which permits of good drainage after the abscess has been opened. After opening the abscess, the cavity is packed temporarily with iodoform gauze; a drainage tube may or may not be inserted. At the end of 24 hours the gauze is removed, the cavity washed out, and a small wick of gauze put in. After the first week all packing should be removed, even the drain, and the wound allowed to heal. It should be watched from time to time, as pockets or the formation of another abscess may take place. When this does occur, the operator, with his gloved finger, can break down the septum and establish drainage. After 3 weeks, if the cavity is not fully healed, we are in the habit of using Beck's paste, bismuth (33½ per cent.) and vaselin.

Causes of Failure.—The failure to cure superior pelvirectal abscesses may be due to many causes. (1) As we have already mentioned, if the abscess is not properly opened, a fistula may result. (2) Failure to appreciate that a superior pelvirectal abscess exists may result in posterior pelvirectal abscess. Draining the superior pelvirectal abscess under these circumstances would most certainly result in failure. (3) The abscess may push the peritoneum before it and present itself in the left inguinal region, just above Poupart's ligament. Under such circumstances the tendency is to open the abscess in the inguinal region. If the abscess is opened in the inguinal region, temporary drainage may result in apparent cure, but the abscess will not be perfectly drained and is likely to give further trouble.

Complications.—The most serious complications are peritonitis resulting from rupture of the abscess into the peritoneal cavity; rupture into the bladder, resulting in infection of the kidney; and urethrorectal fistula as a result of a prostatic abscess rupturing into the rectum; septicemia or pyemia.

FISTULÆ IN ANO

Classification.—Fistulæ may be divided into complete and incomplete. The *incomplete variety* may be external or internal, deep or superficial. Under the head of *complete fistula* are classified all cases where there is a communication between the bowel and the skin, or between the bowel and some adjacent organ.

Symptoms.—The symptoms of fistula are so closely allied with the symptoms of abscess that in all cases the patient will give a history of an acute process, followed by relief, with a constant discharge from the anus, associated with burning, itching, some slight pain on moving the bowel if the fistula has an internal opening, discomfort in sitting, standing, or walking upstairs. Some fistulæ, and particularly the blind, internal variety, give a history of fissure, that is, a burning sensation when the bowels move, plus the discharge of pus and blood.

Indications for Operation.—The presence of a discharging sinus is the indication for operation.

Anatomical Points to Be Noted.—The location of the external opening may, to a certain extent, be of great assistance to the surgeon in locating the internal opening and deciding on the method of treatment. **If the external opening is within 1½ in. of the anus, and anterior to the line drawn from one tuberosity to the other, the fistulous tract is generally straight and the internal opening will be found anteriorly and close to the external sphincter. If the external opening is within 1½ in. of the anus, and posterior to this line, we may expect to find the internal opening in the posterior commissure between the 2 sphincters.** There are exceptions, but these only "prove the rule."

Instruments Used.—The instruments used are as follows: A syringe, such as is used for injecting bismuth paste, which answers a double purpose, as it can be used for injecting the peroxid of hydrogen and methylene blue to locate the internal opening, and also to inject the fistula with Beck's paste, if this is decided upon; a dozen artery forceps; 2 pairs of thumb forceps (one plain, one mouse-tooth); 3 curved, spear-pointed needles of different sizes; a needle holder and cautery (the new cautery is about the best). One should always have a cautery at hand when operating on fistula, because if there is any suspicion of tuberculosis, the cautery must be used in preference to the knife. In addition, 2 or 3 sharp retractors and a speculum (Humphrey's speculum) are needed.

Methods and Choice of Methods.—Innumerable methods have been suggested, from the earliest days to the present, and few surgeons are agreed as to the best. We must be guided, in every case, by the condition existing at the time the patient comes under our observation. If there is a very active suppurative process one would hardly be expected, to excise a fistula. If there is some suspicion of tuberculosis, the fistula may be dissected and sutured; on the other hand, if the skin adjacent to the fistula is unhealthy, by following the procedure I have mentioned, we may disseminate the tuberculous process. **The safest rule to follow, when the surgeon is not experienced, or if there is any danger of soiling the neighboring tissues, is to open the fistula with a cautery.** When we have an extensive suppurative process, a rundown patient, running a high temperature and with multiple external openings, our judgment would dictate a colostomy before attempting to deal with the fistula. Very often, in this way, the temperature of the patient will be brought down to almost normal and he will be in a very much better condition to withstand an operation. A patient with tuberculosis and a suppurative fistulous tract will always be immensely benefited by drainage of the fistula. There are many examples of the virtue of an operation under such circumstances. Patients who were bedridden, with high fever, have been practically restored to health by burning out the fistulous tract with the cautery. Such an instance stands out prominently in my memory.

This case was referred by Dr. Burtenshaw, of Tarrytown. The patient, who was an employee of the Maxwell factory, had been confined to his bed for many months previous to the time he was referred to me. He was running a high temperature, suffered from night sweats, had lost flesh, and looked like a poor risk. Three weeks after his fistula had been operated on, he had gained many pounds and was able to resume his work.

I cite this case because so many surgeons have the idea that a man who has pulmonary tuberculosis should not be operated on for fistula, for fear of complicating his tuberculous trouble. My idea is in keeping with that of modern experience, and it is now quite evident that a mixed infection is harmful to a patient with tuberculosis; so much so that Continental physicians are giving vaccines to their tuberculous patients with mixed infections, as they find that the individual is better able to cope with the tubercle bacilli after the mixed infection has been eliminated.

Any method that will cause obliteration of the fistulous tract should be tried. Many fistulæ have been cured by the injection of a saturated solution of nitrate of silver, pure carbolic acid, permanganate of potash, tincture of iodin, or other drug. As a general rule it may be stated—and this particularly applies to a complete fistula—that any measure short of fistulectomy, or fistulotomy, will give only temporary re-

lief. The different drugs we have mentioned are given because, from time to time, cures have been reported, by the use of one or the other, by such superior men as Goodsall, Miles, and others.

Treatment with Beck's Paste.—Beck's paste is a preparation of ⅓ bismuth and ⅔ lanolin or vaselin. Excellent results have been reported by Beck, Pennington, and others after treatment of fistula with this paste. I have given this method a fair and impartial trial but my only success was in one blind external fistula.

Elastic Ligature.—Among the hypocratic methods in vogue at the present day and, indeed, successfully used in a great many cases, is the elastic ligature. There is no reason why the ligature should not be successful provided it passes from the external opening to the internal opening, and this is accomplished by threading the ligature on the carrier especially adapted for this purpose. After the ligature has been passed, it is fastened by means of a small metal shield or partially divided shot. The precaution should be observed of cocainizing the skin and incising it before clamping the ligature (otherwise, the pressure of the ligature on the overlying skin causes a great deal of pain). We have tried this method on several cases and, while it worked satisfactorily, we are inclined to believe that the patient suffered more pain and inconvenience than he would have had he submitted to the ordinary surgical operation.

The surgical operations that have been found most useful in treatment of fistula are incision, excision, and excision with immediate closure and drainage.

Preparation of the Patient for Operation.—Careful preparation of the patient is necessary no matter which operation is decided on; but this is especially so where excision with immediate closure and drainage is the operation of choice. It is necessary in the last mentioned operation to tie the bowels up for 4 or 5 days, and thorough catharsis is absolutely essential previous to operation. If the patient is seen 2 or 3 days previous to operation, calomel is the most suitable drug, because it is an intestinal antiseptic. This should be followed by a saline or by castor oil. Castor oil has the advantage of thoroughly cleansing the bowels and afterward causing a certain degree of constipation. Calomel should never be administered the day before operation because it stirs up the toxins, and as these toxins are eliminated by the kidneys, its use is unwise, particularly where the patient must take a general anesthetic. On no account should cathartics be administered the night before the operation, since it would then be impossible to obtain a clean field because of the frequent bowel movements.

If an emergency operation is necessary, it is far better to depend on a thorough irrigation of the intestines with peroxid of hydrogen, 2 per cent. In all cases, whether cathartics have been administered or not, it is customary to have the larger bowel irrigated with a 2 per cent. solution of peroxid followed by a normal salt solution. The only other preparation necessary is that which is employed previous to all surgical procedures, i. e. a warm bath the night previous to the operation. We employ no other preparation except the painting of the parts with a 3 per cent. solution of a tincture of iodin just before the patient is put under the anesthetic. No matter what anesthetic is employed, 1/150 gr. hyoscin and ¼ gr. morphin are given 2 hours previous to operation, unless there is some distinct contra-indication to their use.

Before proceeding further it might be well to say a few words concerning the anesthetic to be used. Whenever possible, local anesthesia should be employed; but one should never take the risk of operating under local anesthesia if the patient is nervous and cannot tolerate manipulation, even though the pain is almost nil.

Local anesthesia should not be employed when the fistula is inaccessible on account of the conformation of the parts—for instance, in the case of a fat patient with a funnel-shaped anus. It is also contra-indicated in complicated fistulæ and in cases where there is any doubt as to the ability of the surgeon to operate with ease and comfort while employing local anesthesia.

Local anesthesia is particularly applicable in the case of a blind external and internal fistula where the fistulous tract is straight. Sometimes sacral anesthesia can be employed very successfully.

Determination of the Fistulous Tract.—From time to time many methods have been suggested for following the ramifications of the fistulous tract; but very few of these are absolutely reliable. In the case of a simple straight fistula the flexible probe will meet all the requirements, but even in such cases those who are inexperienced have difficulty in guiding a probe from one opening to the other, especially when the probe is not of the required flexibility, as it is apt to go astray or form a false passage. For this reason I searched for some reliable method that would enable me to follow all the ramifications of a fistulous tract.

After many years of experience with peroxid of hydrogen and methylene blue, I came to the conclusion that this was the most reliable method (3). I have often demonstrated its value as a means of diagnosis and its almost unvarying reliability in those very complicated fistulous tracts where communication between the two fistulæ is so narrow as to make it impossible for any probe to pass, no matter how fine. If this method is followed, it will obviate many failures that undoubtedly result from overlooking some ramifications of the fistulous tract, or neglecting to find the internal opening.

Excision of the Fistula.—This method is safe and reliable when indicated. It is not a good procedure where there is active suppuration. The technic is as follows: The patient, having been previously prepared, is placed in the most convenient position, depending on the location of the fistula. The lithotomy position is the most convenient in the majority of cases (Fig. 10). Occasionally the left or right Sims' position may be preferred, if the fistulous tract extends posteriorly. Peroxid of hydrogen and methylene blue are injected, care being taken not to exert too much pressure, allowing the peroxid and methylene blue to gradually permeate and find their way to the internal opening, if such exists. This method is particularly advised where excision is practiced, because it notifies the surgeon whenever he encroaches on the infected area. An elliptical incision is made around and about ⅛ in. from the external opening of the fistula; then, by means of thumb forceps and scissors, the fistulous tract is dissected up until the interior opening is reached. Just before reaching the opening in the mucous membrane, a probe can be passed from the rectum into the fistulous tract and the tract tied over the probe; by pulling on the probe, it is then possible to invert the fistula and pull it through the rectum. In this way any injury to the muscle is avoided. I have practiced this method in very extensive fistulæ, especially in cases that had had many previous operations with considerable scar tissue.

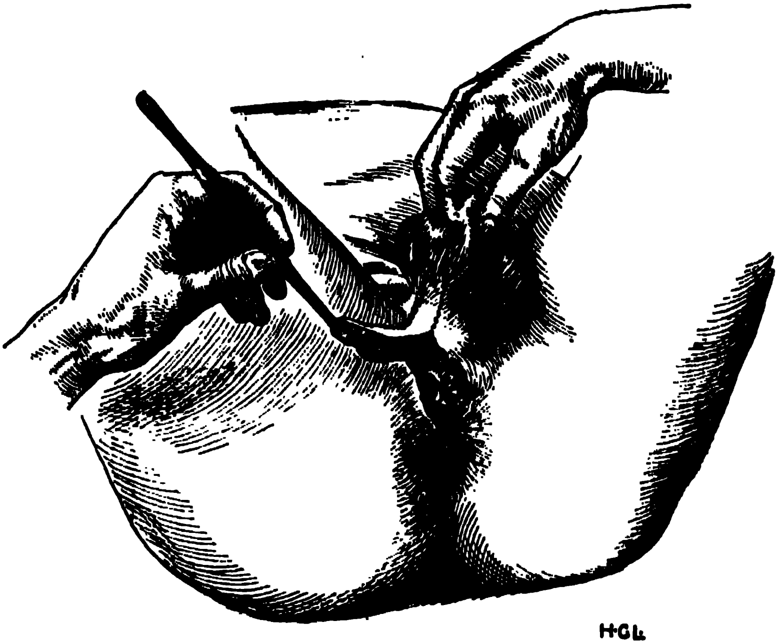

FIG. 10.—FISTULECTOMY. Drawing made at the time of operation from a case operated on at the Rectal Clinic, New York Polyclinic Medical School and Hospital.

The fistula is now packed with iodoform or bismuth gauze and allowed to granulate.

Excision of the Fistula with Immediate Closure of the Wound.—This operation can be performed under either local or general anesthesia. The latter is preferable, unless contra-indicated. It is a most satisfactory method for the treatment of fistula, in suitable cases, from a surgical standpoint.

We have secured primary union, even in tuberculous fistulas, by the method described, afterward drawing down the mucous membrane and suturing it to the surface of the skin some distance beyond the margin of the anus (Fig. 10, A). Thus, the wound adjacent to the anus is covered with mucous membrane, which offers a certain protection against infection following a bowel movement.

Incision is the method most frequently practiced, and, when followed, great care should be taken that the muscle is cut in the correct way. Figure 11 shows the correct and incorrect way of cutting the sphincter. This method accomplishes just as much as any other method provided the internal opening of the fistula has been discovered.

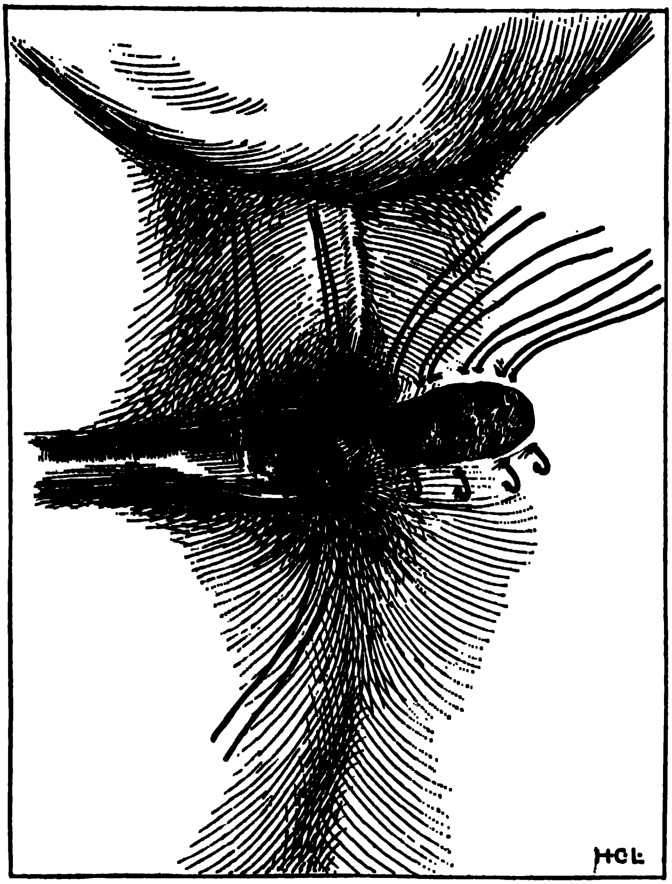

FIG. 10A.—THE GEORGE DAVID STEWART STITCH WHICH WE USE FREQUENTLY FOR CLOSING A DEAD SPACE AFTER FISTULECTOMY.

Suppurative processes occurring in organs adjacent to or distant from the rectum occasionally find an outlet into the rectum. The resulting sinuses are persistent, and if they originate in disease of the bone, such as spinal or sacro-iliac disease, are almost incurable. One should, therefore, be always on his guard, and not undertake hastily or without due deliberation an operation for a fistula, the source of which is doubtful, lest he further incapacitate his patient. Above all he must not attempt to apply the operation of excision with suture to such cases.

The following question is frequently asked: How shall a fistula, the internal opening of which is several inches above the internal sphincter, be treated? In the majority of cases the men who ask this question have in mind the danger of cutting the external and internal muscle at the same time. As a matter of fact, when the internal opening is above the internal sphincter, the fistula does not usually involve the internal sphincter, but burrows up underneath the mucous membrane. Under such circumstances it is perfectly safe to lay the fistulous tract open, and this can best be accomplished by the cautery, as by this method the danger from hemorrhage and sepsis is considerably diminished.

Where the fistula burrows under the internal muscle, then both sphincters have to be cut; and no time should be wasted after the fistula has been eradicated to bring the parts together by means of sutures. Never fail to insert a rubber-tissue drain. Where the fistula is connected with the superior or posterior pelvirectal spaces, these cavities should be opened, preferably from the outside, and drained by means of a rubber tube or rubber tissue.

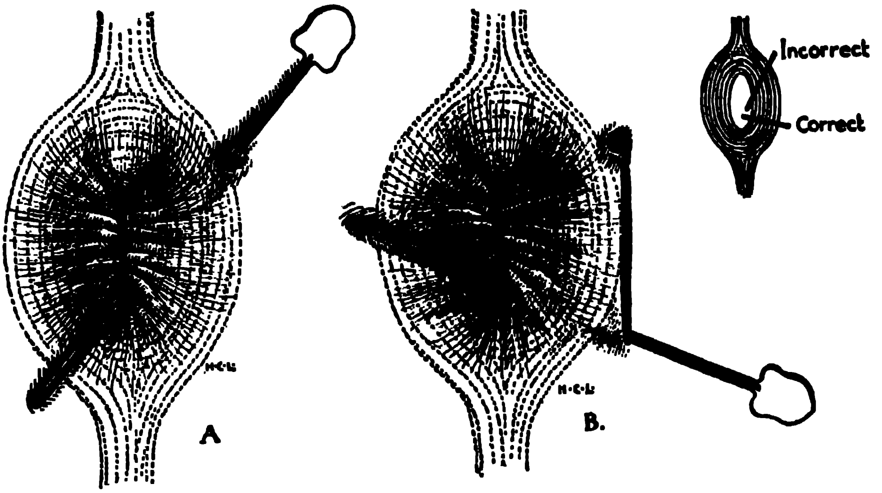

FIG. 11.—THE CORRECT AND INCORRECT METHOD OF CUTTING THE EXTERNAL SPHINCTER MUSCLE.

Complex Fistulæ.—Under this heading are described by most authors fistulæ with many external openings, called watering-pot fistulæ and horseshoe fistulæ. The horseshoe fistula is usually one resulting from an abscess, as shown in Figure 8. This has a common internal opening in the posterior commissure and lateral openings which are the result of an infection passing from the posterior commissure to the ischiorectal fossa. There is no more difficulty in treating these fistulæ than in treating ordinary ones, provided there is not more than 1 internal opening. Their treatment depends upon the number of previous operations, because if the fistulæ have a solid foundation of connected tissue, simple incision is not sufficient. In such cases I prefer to dissect out all the tracts at 1 sitting and try to cover over the raw surfaces by means *of a plastic operation. I have had excellent results by following this method. Fistulæ resulting from an abscess of the vulvovaginal gland, which have dissected around the rectum close to the levator muscle and finally found their way into the rectum posteriorly, should be treated by dissecting the rectum* free from the fistula, closing the opening into the rectum and packing the *wound, then allowing it to heal by granulation. I have had very excellent* results from following this method, and have always succeeded in closing the rectal opening.

Causes of Failure.—Failure in the operative treatment of fistula is usually due to one of 3 causes: (1) Failure to find the internal opening; (2) neglecting to dress the fistula after operation, resulting in imperfect union or pocketing; (3) lateral burrowing tracts overlooked at the time of operation. If the surgeon exercises a careful supervision, there is no reason why he should not get at least 95 per cent. cures. Prolapse of a hemorrhoid, or of the mucous membrane, into the wound after the removal of a fistula very often prevents healing. When this occurs, the hemorrhoid or mucous membrane should be removed under local anesthesia.

Complications.—IMMEDIATE COMPLICATIONS.—DISCHARGE OF INTESTINAL CONTENTS.—The most annoying complication, and one that in a great measure is due to faulty preparation of the patient, is the discharge of intestinal contents over the field of operation. This can be avoided in every case by a thorough irrigation of the bowels beforehand.

HEMORRHAGE.—Severe hemorrhage may occur during the operation, and owing to retraction of the mucous membrane some difficulty may be experienced in stopping it, but it is never a very serious complication, and, except for the delay and annoyance, rarely results seriously or inconveniences the patient.

Postoperative hemorrhage is much more serious, and, unless the surgeon is on his guard, may occasionally result disastrously. One should always be on the lookout for such a complication, especially after local anesthesia. It should not be serious if discovered early, but unfortunately in many cases the patient bleeds into his bowel, and only when profound shock or fainting has ensued is the cause of the trouble discovered. For this reason I always make it a practice to insert a tube into the rectum following operation, so that if there is any hemorrhage, it will immediately be detected.

SHOCK.—This is nearly always the result of severe hemorrhage, and by avoiding the hemorrhage shock can be eliminated.

ACUTE GENERAL SEPSIS.—Acute general sepsis is always the result of imperfect drainage, and is apt to follow when excision of the fistula with immediate suture is practiced and the surgeon neglects to establish drainage for 24 hours. It should never occur if drainage is established, except in those cases where secondary abscesses form at a distance from the original field of operation.

LATE COMPLICATIONS.—The most serious and frequent of late complications is incontinence. It rarely results from a simple division of the sphincter, provided that division is at right angles to the muscle. It occasionally follows a division of the external and internal muscle, even under the most favorable circumstances, and in such cases is due to the rapid growth of the mucous membrane into the wound resulting in a sulcus. It occasionally results from overstretching of the muscle at the time of operation, but in the majority of cases it is due to a total disregard of the value of the sphincter muscle.

The only sure and satisfactory method of treatment is restoration of the continuity of the muscular fibers. Of course there are cases where the muscle has been so destroyed as to make it impossible to bring the ends together; indeed, in many cases it is impossible to find the ends of the muscle, owing to the quantity of scar tissue that has formed and the number of the incisions in previous operations. No one was more successful with this class of cases than the late Dr. Tuttle. I have rarely seen him fail to cure a case except those that were beyond the aid of man. He was the first to lay down the principle that if you wish to accomplish a good result you must approach the muscles at some distance from the anus; accordingly he made an incision at least 1½ in. from the anus, dissected up the flap, brought the ends of the muscle together, closed up the dead spaces, and always established drainage for 24 hours, with the very best results.

When the incontinence is due to an irregular union of the muscle, the best operation consists in shortening the muscle and bringing the fibers into perfect apposition. The credit of this operation is also due to Dr. Tuttle.

Where the muscle cannot be repaired, the operation devised by Chetwood will occasionally remove the incontinence. The Chetwood operation is as follows: A large semicircular incision is made from one tuberosity to the other, the convexity being directed toward the coccyx and a little beyond it. This flap is then turned forward, and the fatty tissue dissected away, exposing the gluteus maximus muscle. A portion of the gluteus maximus on 1 side, about the size of the little finger, is separated from the rest of the muscle, isolated and cut anteriorly. The same process is carried on at the other side. After the 2 pieces of muscle have been isolated, they are made to cross each other beneath the ligamentous attachment of the anus and the coccyx. They are then made to encircle the rectum, but sufficiently close to approximate anteriorly. They are sutured with chromic catgut and the flap returned and sutured in place, drainage being established for 24 hours.

After-treatment.—The after-treatment, to some extent, depends upon the operation that has been performed. If the fistula has been incised and not sutured, the bowels are usually moved at the end of 48 hours. This is accomplished by irrigating with a 2 per cent. solution of peroxid of hydrogen followed by a cathartic. The cathartic selected is usually that which is most agreeable to the patient, or one which he has found by experience agrees with him best. After the bowels have moved, the patient is given an enema of warm normal salt solution, and the wound is dressed, the usual dressing being 10 per cent. solution of balsam of Peru in castor oil.

If the wound is sutured after excision of the fistula, then the bowels are tied up for 5 days. The question is frequently asked: "How is this accomplished?" As defecation is an entirely voluntary act, if the patient is intelligent it is not necessary to administer any drug, but simply to instruct him that his bowels must not move for 5 days. In the majority of cases, however, on account of the pain following operation, morphin or some form of opium has to be administered, so that there is very little difficulty about tying up the bowels for the necessary time.

In the case of hospital patients, the routine treatment is as follows: Before the patient comes out from the anesthetic he is given ¼ gr. morphin hypodermically. If an opiate is necessary after this, he is given 5 to 10 minims of a deodorized tincture of opium 3 times a day. This is usually sufficient to allay the pain and prevent the bowels from moving. At the end of the fifth day the bowels are moved in the manner already described.

The after-treatment of a fistula is more important than the operation, providing the operator has not overlooked the internal opening or any lateral tracts, and it is necessary, in order to accomplish a good result, that the patient should be seen at least 3 times a week for the first 2 weeks after operation, and after that once or twice a week until the fistula is absolutely healed. No operator, if he wishes to get a good result, will delegate the dressings to an assistant, as an assistant never takes the same interest in the case that the operator does.

In the case of the open operation, it is the duty of the surgeon to see that the healing is uniform and that there is no pocketing or bridging. When, at any time, he discovers that the fistula is not draining properly, he should immediately see to it that perfect drainage is established. If, at the end of the second week, the patient complains of pain, the surgeon may be assured that something is wrong, and should be on the lookout for lateral burrowing tracts or the formation of pocketed pus. With competent supervision, there is no reason why a surgeon should not have a perfect result in 95 per cent. of his cases.

COMPLICATED FISTULÆ

Complicated fistulæ are those fistulæ which connect the rectum or anus with adjacent organs and also fistulæ which originate in some of the bony structures surrounding the rectum. One of the most important is the recto-urethral fistula.

Under this heading will be considered (1) recto-urethral fistula; (2) rectovesical, enterovesical, and sigmoidovesical fistulæ; (3) rectovulvar and rectovaginal fistulæ.

Recto-urethral Fistula.—The symptoms of a recto-urethral fistula are the passage of gas and feces from the urethra, or the passage of urine through the rectum; the direction of the fistula will determine to a great extent the nature of the abnormal passages. If the opening into the urethra is above the opening into the rectum, the urine will flow from the urethra into the rectum; and, on the contrary, if the rectal opening is above the opening into the urethra, the gas and feces will pass from the rectum into the urethra.

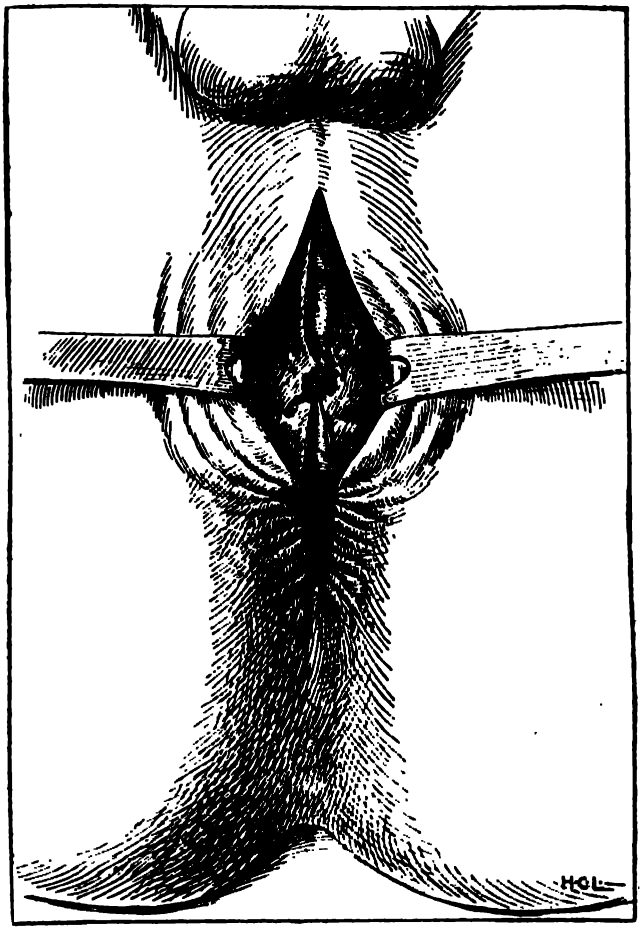

FIG. 12A.—RECTUM, PERINEUM AND URETHRA INCISED TO EXPOSE RECTO-URETHRAL FISTULA.

TREATMENT.—The treatment of this condition is entirely surgical. Almost every surgeon who has attempted to operate on these cases has been impressed with the difficulty of accomplishing a cure.

My late colleague, Dr. Tuttle, had more success with this operation than any other individual surgeon in this country or in Europe. He operated on about 18 cases altogether, and out of the 18 had 16 successes. I feel fairly sure that this is an unusual record. I assisted at 10 of those operations, and can vouch for the difficulties encountered.

The operation, as performed by Dr. Tuttle, is as follows:

An incision is made in the middle line, anteriorly, extending from the scrotum to the rectum. This incision is carried through until the urethra is reached. The urethra is now opened and the stricture at the fistulous opening divided, as in Figure 12A. The cicatricial tissue around the entire fistula is removed either with a knife or with scissors. The rectum is dissected up anteriorly for about ¾ in. above the fistula and ½ to 1 in. on either side. In this way a good exposure of the fistulous opening into the urethra is obtained. A flap is then dissected from the soft tissues on either side of the urethra. This flap should be large enough to cover the floor of the urethra, which has been destroyed. A steel sound, No. 30 French, is introduced into the bladder and over this the flaps which have been dissected from the side

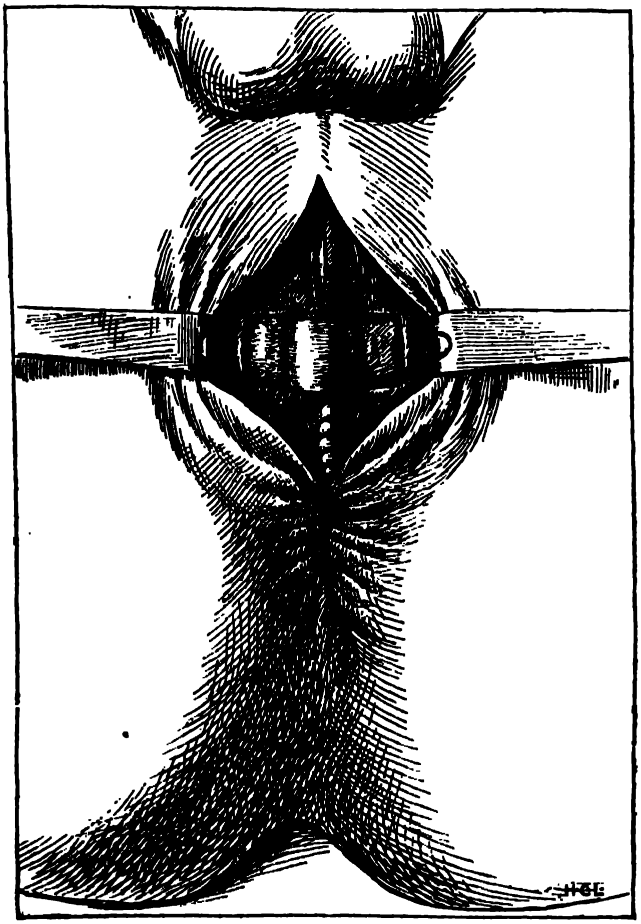

Fig. 12B.—Recto-urethral Fistula and Wound in the Rectum Closed. The incision in the urethra anterior to the fistula is left open.

of the urethra are sutured without tension. Secondary flaps are taken outside of the first flaps, entirely surrounding them, making a cuff to the first area sutured, as in Figure 12B. The edges of the rectal wall are then brought together by means of chromicized catgut sutures, which extend through the entire thickness of the bowel wall (Fig. 12C). In this way the rectal wall, including the cut sphincter muscle, is repaired. The urethra below the site of the fistulous opening is left unsutured (Fig. 12C). A soft rubber catheter is introduced through the meatus and brought out through the opening in the urethra. From here it is re-introduced through the proximal urethra into the bladder. The catheter is fastened to the head of the penis by means of adhesive plaster and the perineal wound covered over with gauze. A large size drainage tube is introduced into the rectum to facilitate the passage of gas, and it is important to keep this catheter in place for a week or 10 days. If it slips out, it should be re-introduced as in the first instance.

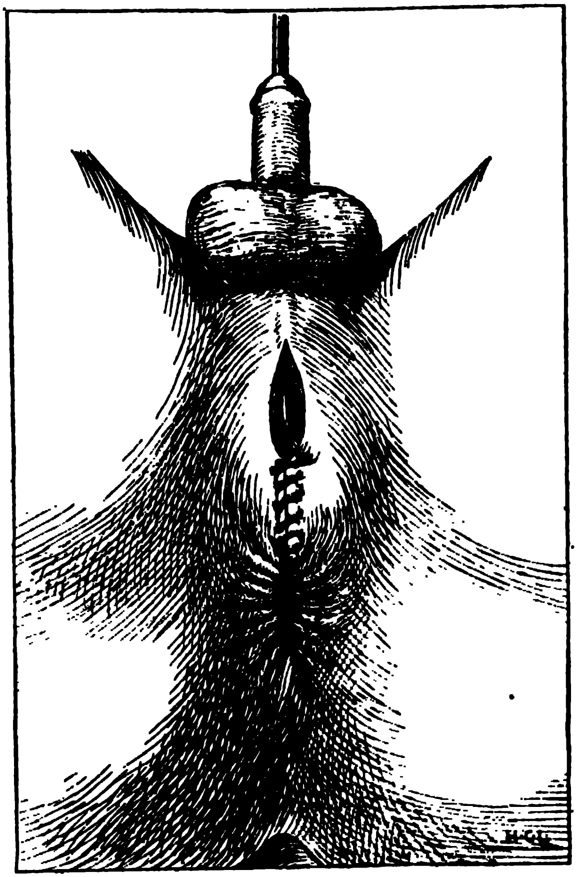

FIG. 12C.—FINAL STEP IN OPERATION FOR RECTO-URETHRAL FISTULA.

Rectovesical and Sigmoidovesical Fistulæ.—Fistulous openings between the rectum and the bladder are comparatively rare, but a communication between the sigmoid and the bladder is of frequent occurrence. This is explained on the ground that diverticulitis occurs more frequently in the sigmoid than in the rectum.

The treatment of rectovesical fistulæ is extremely difficult, but in the majority of cases an artificial anus will give the best result. The treatment of a sigmoidovesical fistula is easier on account of its accessibility.

SIGMOIDOVESICAL FISTULA.—The symptoms of a rectosigmoidovesical fistula are irritation of the bladder with the passage of gas and feces during and following urination; high fever with chills; headache and nausea.

Before operating on the fistula an ileostomy should be performed and the colon thoroughly irrigated for 3 or 4 weeks previous to the contemplated operation for the relief of the fistula. We have also found it a good plan, whenever possible, to use the autogenous vaccines, in order to put the patient in the best possible position to withstand the more serious operation for the relief of a rectovesical fistula. On the morning of operation, the ileostomy should be temporarily closed with catgut sutures and the opening covered with collodion and cotton. The abdomen is painted with tincture of iodin.

After the abdomen has been opened, it is a good plan to clamp the ileum close to the iliac opening. By this means any leakage from the ileostomy is prevented. The small intestines are next packed thoroughly, so that if any leakage occurs of feces or urine the peritoneal cavity will not be infected. All adhesions are carefully broken up and the sigmoid separated from the bladder until the fistulous opening is reached. The next step consists in dissecting out the fistula from the bladder wall and closing the wound in the bladder with 2 layers of sutures. After this has been accomplished, either of 2 methods may be followed. The diseased sigmoid can be resected, with end-to-end anastomosis, or the three-step method of Tuttle can be adopted.

Rectovaginal and Rectovulvar Fistulæ.—RECTOVULVAR FISTULÆ.—Rectovulvar fistulæ are nearly always the result of injuries or suppuration of the glands of Bartholin.

SYMPTOMS.—The symptoms are ordinarily those of a vulvar abscess which has been improperly treated or neglected. The patient complains of soreness in walking, standing and sometimes during micturition after the abscess has ruptured into the rectum, and we have the added symptoms of rectal fistula.

TREATMENT.—The best method of treatment, where possible, is dissection of the fistulous tract, closing the opening in the rectum, and closing the upper part of the wound by catgut sutures, or draining the lower part, or packing the wound and allowing it to heal by granulation.

RECTOVAGINAL FISTULA.—Rectovaginal fistula is a frequent occurrence.

SYMPTOMS.—The symptoms are the passage of feces and gas through the vagina at the time of defecation.

TREATMENT.—Some surgical procedure is necessary in all these cases. In very severe instances, where the suppuration is extensive, a colostomy will be frequently followed by the disappearance of the suppuration and the healing of the fistula. Many operations have been suggested, but the simplest and best procedure is that suggested by Ferguson and Lowenstein. Lowenstein's method consists in freshening the fistulous tract down to the rectal mucosa from the vaginal surfaces, and then closing the opening by means of silver wire sutures. Ferguson, on the other hand, dissects up a cuff of mucous membrane, upon the vaginal side, about ½ in. outside of and surrounding the fistulous opening. This cuff is dissected inward toward the fistula, and is somewhat similar to that adopted by Tuttle for closing the urethral rectal fistula. The flap closes the opening in the rectum temporarily, and prevents the escape of gas and fecal material into the fistula until the freshened surfaces have had an opportunity to heal.

The technic employed by Tuttle is a complete excision of the fistulous tract combined with perineorrhaphy. The sphincter muscle is first stretched, and after this the perineum is completely incised from the vagina into the rectum; but one must not open into the fistula. A probe is now passed through the fistula from the vagina into the rectum, and the fistulous tract around the probe is completely removed, together with any cicatricial tissue that may exist. All the cicatricial tissue must be removed or union will not result. The rectal mucous membrane is next dissected up, as in a Whitehead operation. When sufficient mucous membrane has been brought down, so that the healthy mucosa will cover the outside wound for about half an inch, and all the diseased tissue has been removed, the surgeon proceeds to close the perineal opening after the manner of Emmet. When the perineal wound has been closed, the flap of mucous membrane in the rectum is brought down and sutured to the skin margin of the anus. The mucous flap closes all communication between the rectum and the perineal wound. After this, a drainage tube is inserted in the rectum to facilitate the passage of gas. The bowels should be tied up for 5 days. At the end of this time the rectum is washed out with a 2 per cent. solution of peroxid of hydrogen, followed by a cathartic. Great care should be taken to see that the rectum is irrigated with a normal salt solution every time the bowels move. For the first few days after the operation the patient should be catheterized to prevent soiling of the wound.

TUBERCULOUS FISTULA

The question as to what percentage of fistulæ are tuberculous has not been definitely settled. I have heard teachers of surgery state that 90 per cent. of fistulæ are tuberculous.

While this may have been the experience of the men who made this statement, I feel confident that this percentage is not based on histological findings. In my own clinic not more than 5 per cent. of all the cases seen are tuberculous, and I am sure that more fistula cases are treated in my clinic than in any other 2 or 3 clinics together in this country. The fact that a patient suffering from pulmonary tuberculosis

has a fistula does not prove that the fistula is tuberculous, nor should we come to the conclusion that a fistula in a man otherwise healthy, with no evidence of pulmonary tuberculosis, is not tuberculous.

The tuberculous fistula has certain characteristics which distinguish it from the ordinary fistula; but these characteristics should not be relied on entirely, and, where there is any doubt in the mind of the surgeon, the fistula should be treated as tuberculous.

HEMORRHOIDS

Hemorrhoids are usually divided into external and internal. There are several subdivisions of both, but the most important type is internal, the so-called raspberry hemorrhoid. This type is usually troublesome on account of the fact that it prolapses and bleeds, and it is also the type that results in secondary anemia by gradual loss of blood. The ordinary internal hemorrhoids may exist for a long time and attain an enormous size without causing the patient any more inconvenience than having to replace them after a movement of the bowels (Fig. 13). Of the external hemorrhoids, the most important type is the thrombotic.

THROMBOTIC HEMORRHOIDS

Symptoms.—The symptoms of thrombotic hemorrhoids are a sharp, sudden pain, following straining, lifting, or violent exercise, succeeded by a swelling which gradually increases in size; subsequent spasm of the sphincter, with a dull aching pain; and an uncomfortable feeling when sitting or walking.

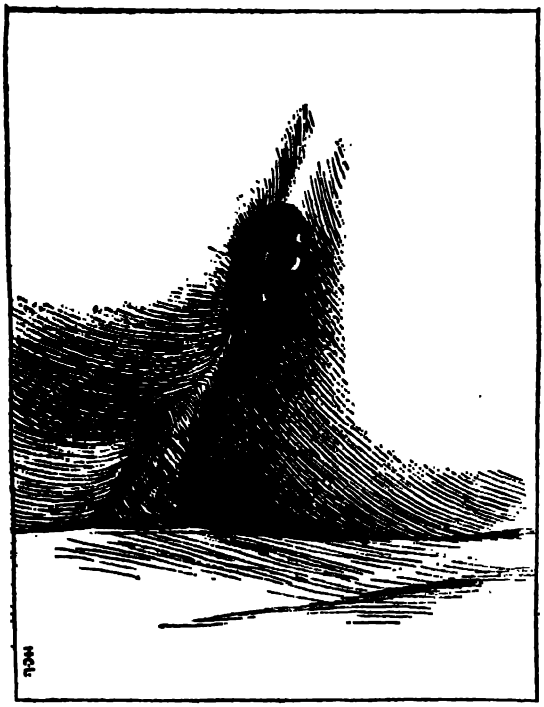

FIG. 13.—A PROLAPSED BLEEDING HEMORRHOID.

Instruments Used.—The instruments used in the surgical treatment are a hypodermic syringe, a knife, dissecting forceps, and scissors, and 2 or 3 artery forceps.

Treatment.—There are 2 methods other than medical of treating thrombotic hemorrhoids and they both aim at the same result, that is the removal of the clot and subsequent primary union of the wound. The usual method is as follows: The skin having been previously painted with tincture of iodin, the patient is placed in whatever position is found most convenient, usually the right or left Sims' position, depending, of course, on which side the tumor is located. If the tumor is very large, it is removed by an elliptical incision, the procedure usual for any skin tumor, and the skin is subsequently closed by interrupted sutures. The common operation is as follows: Before injecting the cocain a few drops of carbolic acid are applied to the skin at the base of the tumor to anesthetize and sterilize the point of introduction of the needle. A little cocain is injected at this point and is continued in a line which bisects the tumor until a point on the other side is reached. A radial incision is made through the tumor and the clot turned out. After the clot has been turned out, either of 2 procedures may be followed. A little gauze is placed where the clot was removed and allowed to remain for 24 hours, at the end of which time it is removed and some ointment, such as ichthyol, applied; or (2) a few stitches are taken in the skin and fluffed gauze placed over this, sufficient to cause pressure when the buttocks are strapped with adhesive plaster. At the end of 24 hours the plaster is removed, also all the dressings, and this is usually sufficient. The subsequent treatment consists in keeping the parts washed with alcohol. At the end of 2 or 3 days the patient is well.

INTERNAL HEMORRHOIDS

Indications for Operation.—The indications for operation are the presence of a tumor, whether external or internal, resulting in pain, hemorrhage and reflex disturbances. These reflex disturbances may be referred to the prostate or to some other part of the genito-urinary apparatus, or may cause disturbances in the digestive apparatus.

Anatomical Points to Be Noted.—The anal canal is a slit-like opening by which the rectum communicates with the exterior. It extends from the levator ani to the skin. The lower half of this canal is lined with squamous epithelium. Its direction is downward, then posteriorly, and it is guarded by 2 muscles, the internal and external sphincters. The mucous membrane of the lower half of the anal canal presents a number of rectal folds which are known as the columns of Morgagni. These columns, according to Cunningham, are formed by the infolding of the mucous membrane and contain in their interior some muscular fibers, a vein and an artery. Frequently, at the lower end of the column, will be seen a varicose condition of the vein. It is here that hemorrhoids originate, and this is known as the hemorrhoidal area. Between the columns are folds of mucous membrane resembling the semilunar valves of the heart. These are known as semilunar valves of Morgagni. A fissure, an abscess, an ulceration, or a fistula may have its inception at the bottom of these pockets. Ball has recently advanced the theory that these valves are the remains of the cloacal membrane.

Instruments Used.—The instruments used in the operation depend to a great extent on the operation and the operating surgeon; however, it is well to have in one's armamentarium all the instruments needed in any emergency. They are as follows:

1 scalpel.
2 mouse-tooth and 2 plain thumb forceps.
2 pairs of scissors curved on the flat.
6 Kocher artery clamps.
6 T clamps.
1 ether cautery.
2 half-curved, spear-pointed needles.
No. 2 and No. 4 plain catgut (No. 4 is only used in Whitehead operations).
Iron-dyed linen.
1 Tuttle's hemorrhoidal forceps.
1 hemorrhoidal clamp.

Choice of Method.—No one operation that we know of is suited to all cases and it is very much better for the surgeon not to become wedded to any particular operation, but to adopt the procedure which best suits the particular case under treatment. There is less pain following the clamp and cautery than any other method, with the exception of the Whitehead operation. The danger from hemorrhage is the same in all these operations and only in a very small percentage of cases does it occur. In selected cases, especially where there is a prolapse of the hemorrhoid with a redundancy of the mucous membrane, the Whitehead operation in my hands has proved to be the most satisfactory. I know that a prejudice exists against this operation, but in the majority of cases bad results occur only in the hands of those who have not had sufficient experience with this particular procedure, or who, owing to some mishap at the start, are naturally prejudiced against performing it again. I have no particular choice, as a general rule, and find some good in each operation; my only preference being for the Whitehead procedure in a limited class of cases.

Palliative Treatment.—The treatment of internal hemorrhoids may be either palliative or curative. The palliative treatment is used when operation is contra-indicated, or when the patient objects to any other procedure. The principles involved in the palliative treatment of hemorrhoids consist in making the patient comfortable, arrest of hemorrhage and prevention of prolapse. A great deal can be accomplished by rest in bed, application of astringents, and cold or hot applications.

The diet should be regulated, alcohol interdicted and coffee and tea taken in moderation. Over-eating is very often as injurious as over-drinking, and any measure that will relieve the liver of some of its responsibilities will help to relieve the hemorrhoids.

The regulation of the bowels is particularly important, because a great many people suffering from hemorrhoids also suffer from constipation, indeed it is difficult sometimes to decide which of these conditions is the cause and which the effect. Therefore, any laxative that will give the patient an easy movement and relieve the colon is a step in the right direction. However, it is important to select a suitable cathartic, as some aggravate rather than relieve; among those to be used we might mention cold water. Medicated enemas are also satisfactory. To relieve the edema that sometimes results after a prolapse, a little gauze saturated with boroglycerin may be used, and over this a hot-water bag. The following prescriptions have been found useful:

℞ Ungt. tannic acid	ʒiii
" stramonii	ʒiii
" belladonnæ	ʒii

Sig. Apply twice daily.

℞ Ungt. tannic acid.
Sig. Apply morning and evening.

℞ Ext. suprarenalis	ʒii
Vaselin	℥i

Sig. Apply once daily.

Electrolysis.—This method sometimes succeeds in effecting a cure, but it should not be relied on, and in the majority of cases is only a palliative method. The method of applying the electrolytic needle is as follows:

The hemorrhoid is brought well into view, and the surface painted with a solution of cocain, 10 per cent.; or a mild solution may be injected directly into the hemorrhoid. Four or 5 sewing needles mounted on a handle are passed into the center of the tumor, and the needle, by means of a cord, is connected with the negative pole of an ordinary galvanic battery. The negative pole can be distinguished from the positive by placing the 2 electrodes in a glass of water; the electrode from which the more bubbles arise is the negative. The needle having been introduced and the connection made, the surgeon should wait until the surface of the pile turns white. After this the needles are withdrawn, the hemorrhoid replaced, and some soothing ointment applied. The patient should be instructed to remain quiet for 24 hours, and if, by any chance, the hemorrhoid which has been treated should prolapse, it must be immediately replaced.

Injection Treatment.—This method of treatment consists of the introduction into the hemorrhoid of a solution (and the basis of nearly all solutions used is carbolic acid) which produces an inflammatory induration and thrombosis of the blood-vessels, followed by shrinkage of the hemorrhoid. The following are some of the solutions that have been found useful:

℞ Acidi carbol. cryst.	**℥i**
Aquæ destillate	**℥ii**
Sodii bibor. et plumb. glyc.	**ʒvi**

Mix and label it Application for Hemorrhoids.

℞ Ac. carbolic	**℥ii**
Ac. salicylic	**ʒp**
Sodii biborate	**ʒi**
Glycerin (sterile) grad.	**℥i**

Mix and label it Solution for the Injection of Hemorrhoids.

The technic of the operation follows:

The patient is prepared as for any other similar operation. The hemorrhoid is brought well into view, and carefully washed with a solution of alcohol. The needle is introduced at the juncture of the tumor with the normal mucous membrane, and carried well across the face of the tumor; but care should be taken that the needle does not perforate the mucous membrane at the other side of the tumor. After the needle has been introduced, a few drops of the solution should be deposited in the middle of the hemorrhoid and a few drops more deposited as the needle is gradually withdrawn. After this, the needle is drawn up toward the apex of the tumor, and the same process repeated; before the needle is withdrawn a little cotton soaked with alcohol is placed over the place from which the needle has been taken. After a few minutes, the tumor is re-introduced into the anus, and the patient instructed to remain perfectly quiet for 24 hours. If the tumor prolapses, he is instructed to immediately replace it. Only 1 tumor should be injected at a sitting. In the course of 3 or 4 days, if no reaction has occurred, the other tumors are treated in a similar manner. One, occasionally, has to inject a hemorrhoid more than once in order to get a result.

A suppository of opium and belladonna, to prevent the bowels from moving and to relieve the pain, having been inserted, the patient is left to rest. After 48 hours the bowels are relieved by an enema.

Ligature Operation.—Galen recommended the use of a strong flax thread made to traverse the base of the tumor by means of a needle, the ligature was then tied on each side, and the tumor permitted to slough off. In 1813 the ligature operation was quite popular with French surgeons; but later, owing to some accidents, it lost this popularity.

Excision alone was practiced by such men as Hippocrates, Galen, Celsus, Ætius, Albucasis, Rhazes, and others. From this we can see that very little change has taken place since the time of Hippocrates, and that the operations, as then practiced, are still in vogue with slight modifications.

The ligature operation is the one of choice at St. Mark's Hospital in London, and there it has been practiced for almost a century with great success. The technic is as follows:

The patient, having been prepared for operation, is placed either in the Sims' or the lithotomy position; in this country the lithotomy is preferred.

The sphincter having been dilated, each hemorrhoid is grasped with an artery forceps and brought into view. There are usually 3 hemorrhoids, 2 anterior to the posterior commissure, and 1 posterior to the anterior commissure and a little to the right. Often a fourth pile is also present, usually at the left side. The hemorrhoids having been brought into view (Fig. 14), the surgeon now proceeds to remove them in the following manner:

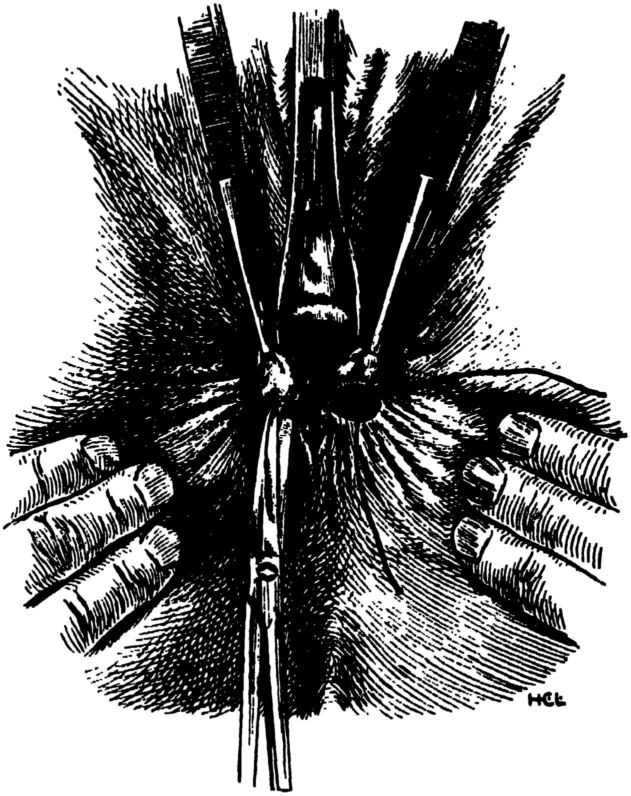

FIG. 14.—THE METHOD OF TREATMENT IN A CASE LIKE FIGURE 7.—Drawing made during operation on Figure 7.

The order of procedure is from left to right. The surgeon takes the forceps with which the left lower pile has been secured and lifts it up. If there is an external pile corresponding to this, or a redundancy of the skin, the skin should be removed. An incision is made in the skin and the dissection continued until the pile has been excised except for a small pedicle. The assistant now holds up the pile, while the surgeon proceeds to tie the pedicle with a silk suture close to the mucous membrane (Fig. 14); the other piles are tied in like manner. After they have all been removed a Sims' speculum is inserted, and the parts closely inspected to see that there is no hemorrhage.

If no hemorrhage occurs, the Lynch tube, covered with a sterile vaselin, is inserted. This has a two-fold object: (1) It allows the gas to pass out;

(2) *if there is any hemorrhage, it enables it to be detected immediately. Without the tube the patient very often bleeds into his bowel, and not until he is in a state of collapse will the fact be discovered that he has a hemorrhage.* The objection to the operation just described is the fact that the ligature is apt to slip. For this reason transfixing the stump of the hemorrhoid with a needle threaded with silk, and afterward tying both sides of the stump is a safer procedure. This method was introduced by Dr. Matthews of Louisville.

THE AFTER-TREATMENT.—The bowels are confined for 48 hours by means of morphin or opium. When there is pain we prefer morphin in doses of 1/4 gr. We have found from experience that it is a waste of time to temporize with smaller doses, as nothing short of 1/4 gr. will relieve the pain in the majority of cases. At the end of 48 hours an enema of a 2 per cent. solution of peroxid is administered. The object of this is to remove the hard fecal matter that may have accumulated in the lower bowel. Afterward the patient is given a cathartic, the choice of which is left to the individual. Whatever one he has found by former experience to give the best result should be the choice. After the bowels have moved, a warm saline enema is given. The treatment after this consists in keeping the bowels clean by means of a normal salt solution after each movement. The gloved finger should be introduced 2 or 3 times a week, as by this means stricture is obviated.

Clamp and Cautery Operation: Cusack's Operation.—The technic of the operation is as follows: The patient having been prepared in the usual manner and placed in the lithotomy position, the legs are held in place by means of a Clover crutch. The hemorrhoid on the left side is grasped with a Tuttle forceps and brought into view. The skin tabs are clipped off flush with the skin. This obviates the edema which will follow if an excessive amount of skin is left after the operation. A clamp is now placed on the tumor, with the heel of the clamp toward the upper portion of the hemorrhoid. The blades of the clamp should fit into the skin incision. The forceps should now be removed and the tumor cut off within 1/4 in. of the clamp, thus leaving a stump which can be thoroughly charred. The clamp is gradually removed and the surgeon observes the stump to see that there is no bleeding as it recedes into the anus. Satisfied that there is none, he applies the same procedure to the other hemorrhoids. A very small Lynch tube, previously covered with sterile vaselin, is introduced into the rectum, and over this some fluffed gauze is placed. The patient is now turned on his face and the buttocks strapped with adhesive plaster. Care should be taken to allow the end of the tube to protrude between the 2 pieces of adhesive plaster. The patient is given 1/4 gr. morphin before he comes out of the anesthetic, as by so doing he is tided over the most painful period and in many cases will not require a subsequent dose. The bowels are then tied up for 48 hours. At the end of this time the dressings are removed and the patient is given a peroxid enema followed by a cathartic. The subsequent treatment is the same as that already described in the ligature operation.

Whitehead Operation.—The Whitehead operation is indicated when there is a marked prolapse of the hemorrhoids with a redundancy of the mucous membrane.

This operation is very unpopular with many surgeons. The objections offered are: (1) The uncertainty of primary union; (2) the amount of blood lost; (3) the difficulty of the technic; (4) the formation of stricture following the operation. This is not an operation that should be performed by the inexperienced; but in the hands of those who are adept it has given better results, **when indicated**, than any other surgical procedure known. In the majority of cases it should be performed in 15 minutes, and with very little loss of blood. If a proper approximation of the mucous membrane is made, and the patient is carefully watched after operation, a stricture should not result.

The patient having been thoroughly prepared for operation (and the preparation of the patient is of particular importance in the Whitehead operation), the lower bowel is thoroughly emptied; otherwise soiling of the wound is apt to occur during operation, under which circumstances primary union can hardly be expected. The technic is as follows: An incision is made in the posterior commissure between the mucous membrane and the skin. Through this incision a scissors curved on the flat is passed and the mucous membrane gradually separated from the surrounding tissue. The posterior incision is continued on both sides up to the anterior commissure, where the mucous membrane is closely attached to the muscular wall of the bowel. Whenever possible, this attachment should be allowed to remain, as it offers several advantages. First, it acts as a fixed point so that if, by any chance, the suture gives way, the mucous membrane is still held at this point. In the second place, when infections occur anteriorly, involvement of the superior pelvirectal space is avoided by allowing the attachment to remain. The cuff of mucous membrane is now caught with T-forceps and is dissected up with the scissors until healthy mucous membrane is reached and the hemorrhoidal bearing area is detached from the muscular wall. A longitudinal incision is made in the mucous membrane from the mucocutaneous margin up to a point where the mucous membrane is healthy. Each flap thus formed is caught by T-clamps, and the mucous membrane, with the hemorrhoids attached, is brought down and held down by an assistant. The next step consists in making a transverse incision in the mucous membrane above the hemorrhoidal area, little by little, and after each incision suturing the mucous membrane to the edge of the mucocutaneous surface, the hemorrhoidal portion of which is cut off, being held out of the way by an assistant.

The bleeding during the dissection, especially from the blood-vessels which have been cut in the transverse section of the mucous membrane, is easily controlled by mattress sutures, so that very few blood-vessels have to be tied during operation. An inch tube is now inserted, the patient placed on his abdomen, some fluffed gauze placed around the outside of the tube, and the buttocks brought together by means of adhesive plaster. The end of *the tube should be allowed to protrude outside of the adhesive plaster so that if any hemorrhage occurs it can be readily detected.* The patient is given ¼ gr. morphin before he is returned to bed.

After-treatment.—The bowel should be tied up for 5 days. I am in the habit of giving my patients 5 to 10 minims of deodorized tincture of opium 3 times a day after the operation. If at any time following the operation there is a rise of temperature and there is any suspicion of infection or accumulation of serum, the patient should be immediately irrigated with a warm saline solution. This irrigation should be kept up for at least 20 minutes. The best method of administering this irrigation is by using a return flow tube—such as that devised by Jelks, or any of the return-flow tubes on the market—or a couple of catheters. The point is that the warm water should be kept going until such time as the congestion is relieved, which usually takes from 15 to 20 minutes. I have found this method almost invaluable following the Whitehead operation, and I believe that if it was followed as a routine measure in all cases the best results would accrue. To the opponents of the Whitehead operation I would say that a serious stricture never follows unless the operation has been imperfectly performed, with retraction of the mucous membrane accompanied by suppuration. I have in mind a case which came under my observation, following an imperfect operation, where stricture of the rectum might have resulted but for the patience and perseverance of the patient. As it was, the result was perfect 6 months after operation; no cutting operation was performed to relieve the stricture, but everything necessary was accomplished by diligent and careful dilatation.

A dangerous complication of severe infection with multiple abscesses of the portal circulation has been reported. When such infections arise, nothing can be done; but if one gives ordinary care and attention to the preparation of the patient and to the technic of the operation such results as abscesses surrounding the rectum, superior and posterior pelvirectal abscesses, ischiorectal abscesses, and infection around the rectum are not likely to occur. I have seen an ischiorectal abscess that resulted from an incision into a hemorrhoid. If this complication arises, opening of the abscess as soon as possible is the only treatment.

Ulceration and Fissures Following Operative Treatment of Hemorrhoids.—Ulcerations and fissure have followed the Whitehead, clamp and cautery, and ligature operation. When this complication arises, it is usually the result of neglect on the part of the surgeon to examine his patient from time to time after operation. Sometimes, however, such a complication may result from the inability of the surgeon to make a proper examination on account of the extreme nervousness of the patient or his susceptibility to pain. When such a case comes under one's care, he should state the necessity to the patient, and if the patient cannot stand an examination except under an anesthetic, then the parts must be carefully examined under anesthesia.

PROLAPSE OF THE RECTUM

Prolapse of the rectum is divided into complete and incomplete. Prolapse is spoken of as complete when all the coats of the bowel are involved; as incomplete when only the mucous membrane is at fault. It may be congenital or acquired. Congenital prolapse occurs when the natural supports of the rectum are loose and stretch easily or when the culdesac is very deep. Acquired prolapse may follow removal of the uterus. Relaxation of the perineum or levator muscle is also the result of tumors, straining at stool and various other conditions.

INCOMPLETE PROLAPSE

The incomplete variety of prolapse usually occurs in children and is easily treated by any of the palliative methods in vogue, such as strapping the buttocks, having the child move its bowels lying on its back, injecting warm water previous to stool, etc.

The injection treatment I regard as risky, since sloughing may result with a severe infection not easily controlled. When the injection method is used, 3 to 5 minims of Shuford's solution injected at several points around the circumference of the bowel is perhaps the safest, if one can call any method of this kind safe.

If the measures we have mentioned are not sufficient, one can always resort to more radical means, such as some modification of the Whitehead operation. However, in young children palliative measures are usually sufficient if the cause is removed. Cauterization as advised by Allingham will sometimes overcome the prolapse. This may be accomplished by making an incision all around the rectum between the mucous and mucocutaneous surface and removing the excess of mucous membrane, suturing the mucous to the mucocutaneous edge of the wound; or the excessive mucous membrane can be removed by clamp and cautery, treating it as one would treat a hemorrhoidal condition. This method was employed by the late Henry Smith with very good results.

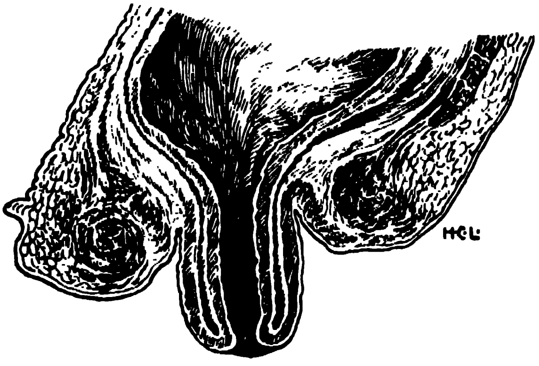

FIG. 15.—PROLAPSE OF THE RECTUM.

COMPLETE PROLAPSE

All the walls of the bowel are involved in this form of prolapse (Fig. 15). There are 3 subdivisions or degrees of complete prolapse. One may gradually merge into the other; but in the majority of cases, from the standpoint of treatment, these subdivisions are important in that the treatment that can be applied to one can not be applied to all. To illustrate, a prolapse of the first degree can be treated very successfully with a simple operation such as the one used and advised by me. But this operation would be worse than useless in the other degrees of prolapse. Then again, all cases of prolapse do not originate from the same cause. A third degree prolapse is probably due to a weakening of the fascia and relaxation of the broad ligaments and deep culdesac. It may follow hysterectomy or be due to a tumor, etc. In the first degree prolapse there is generally a relaxed condition of the pelvic diaphragm and pronounced cases are only an exaggeration of the ordinary prolapse that one sees in severe hemorrhoidal conditions. The symptoms are as follows: Protrusion; passage of mucus, with or without blood; tenesmus. Constipation is usual except when the mucous membrane becomes ulcerated, and then the patient suffers from diarrhea.

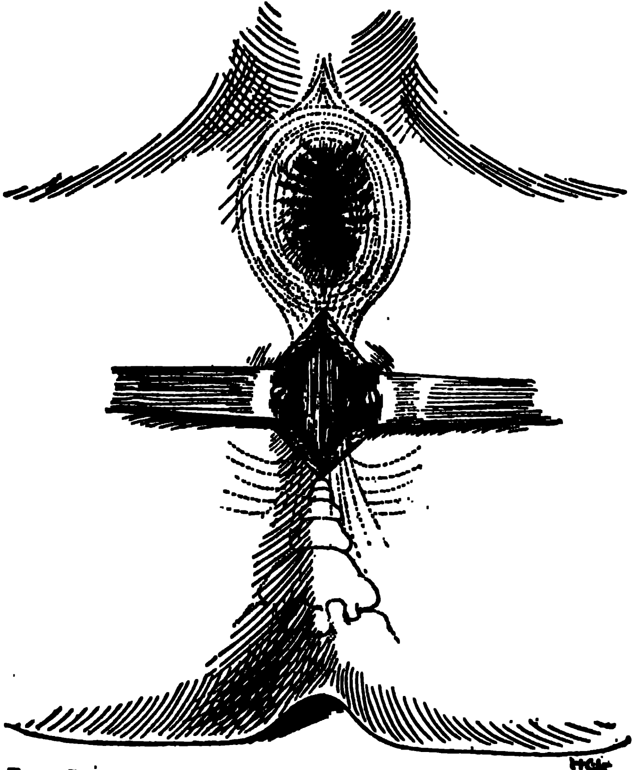

FIG. 16.—FIRST STEP IN LYNCH'S METHOD OF TREATING PROLAPSE OF THE RECTUM.

PROLAPSE OF THE FIRST DEGREE

The operation to be selected in case of prolapse must depend to a great extent on the degree of the prolapse. In prolapse of the first degree my own operation is about as satisfactory as any. It is simple, easily performed, and should give satisfactory results provided infection does not ensue. The technic is as follows:

Author's Method.—The patient having been prepared in the usual manner, the parts are painted with tincture of iodin and the patient is put in an exaggerated lithotomy position well over the edge of the table. A vertical incision is made from about ¼ in. back of the posterior commissure to the coccyx. The parallel fibers of the external sphincter are incised, and the incision continued through the levator ani muscle and fascia. After the levator muscle is divided, it is held apart by means of 2 retractors (Fig. 16). The rectum is now brought out through the incision, as in Figure 17, and scraped with a dull curet. Six longitudinal sutures are inserted, as in Figure 17, and tied as in Figure 18. By this means the posterior wall of the bowel is folded on itself. Three transverse sutures are now inserted (Fig. 18) and brought out on either side of the sacrum and coccyx and tied over a piece of gauze (Fig. 19). The levator ani muscle is brought together by 2 or 3 plain catgut su-

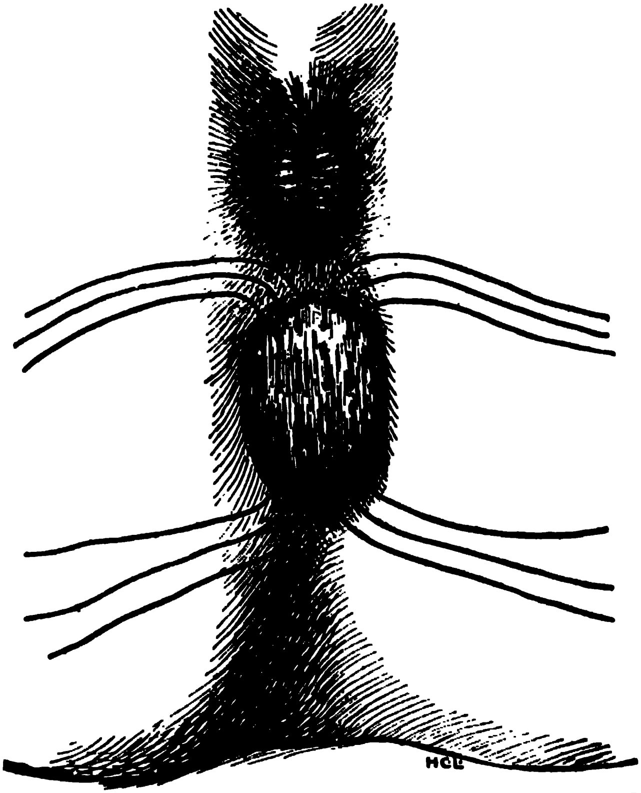

FIG. 17.—SECOND STEP IN LYNCH'S METHOD OF TREATING PROLAPSE OF THE RECTUM.

tures, care being taken not to tie the sutures too tight but just sufficiently to bring the muscle fibers in apposition. The fascia of the levator is closed by interrupted chromic catgut sutures, and the skin by means of a continuous suture.

Tuttle's Method: Proctopexy.—After the patient has been prepared in the usual way, he is placed in the left Sims position, with the thighs flexed on the abdomen. A semicircular incision about 2 in. long is made midway between the anus and coccyx. This incision is carried through all the tissues until the levator muscle is reached. Here the incision should be longitudinal. After the levator muscle has been divided, the rectum is separated from the sacrum, with the gloved 3 fingers, as high as the attachments to the mesorectum and as far as the attachments to the lateral ligaments. The anterior surface of the sacrum and the coccyx is scraped with a dull curet. An assistant reduces the prolapse and inverts it through the posterior opening. The operator catches the rectum and drags it down as far as it will come. After this has been accomplished, the muscular wall of the bowel is curetted as was the sacrum. Silkworm-gut sutures are passed transversely through the muscular wall of the bowel, embracing as much of the circumference of the gut as

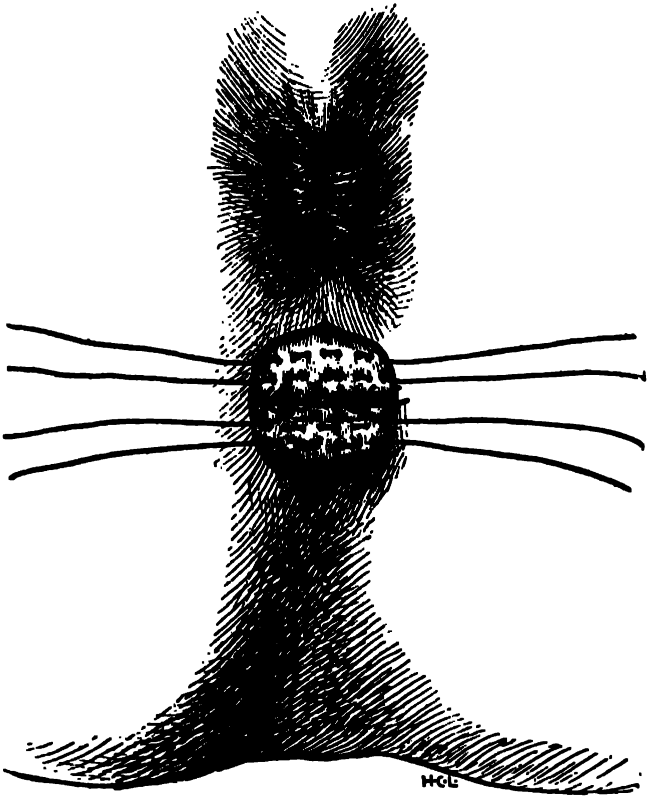

FIG. 18—THIRD STEP IN LYNCH'S METHOD OF TREATING PROLAPSE OF THE RECTUM.

possible. The sutures are placed about ½ in. apart. After the sutures have been placed, the highest one is threaded on the end of a Peasley needle and carried up through the wound to the highest point of separation between the rectum and the sacrum and brought out through the soft tissues on either side of the bone. The other sutures are treated in a like manner, each being brought out about ½ in. lower than the preceding one. A piece of gauze is laid over the sacrum, and the sutures tied pretty snugly over the gauze.

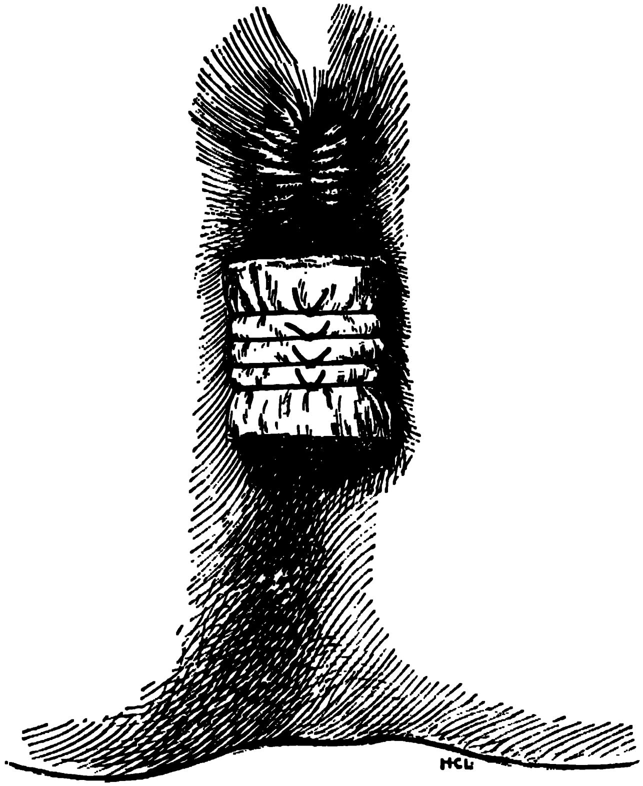

FIG. 19.—FOURTH STEP IN LYNCH'S METHOD OF TREATING PROLAPSE OF THE RECTUM.

By this means the gut is anchored in close apposition with the sacrum. Adhesions are later set up which hold it firmly in position. The wound is closed in the usual manner. This operation was very successful in the hands of the late Dr. Tuttle.

PROLAPSE OF THE SECOND AND THIRD DEGREE

For a prolapse of the second and third degree a somewhat different operation is necessary. A number of operations have been suggested, namely, rectopexy, colopexy, and obliteration of the culdesac, as followed by Moschcowitz.

Rectopexy (Lynch's Operation).—The abdomen is opened in the usual manner, and the patient is placed in the Trendelenburg position. The small intestines are carefully packed off and a self-retaining retractor placed in the wound. The sigmoid is brought out and held by an assistant. The operator now proceeds to cut both leaves of the mesorectum down to the culdesac. After this is accomplished, if the culdesac is deep, it is separated from the bowel by continuing the incision across the rectum. The assistant next lifts the sigmoid, and with it the prolapsed rectum. The next step consists in suturing the mesorectum to the anterior muscular band. By this procedure the rectum is firmly attached and prevented from prolapsing. The final step is accomplished by closing the culdesac. If necessary, and as an added precaution, the peritoneum is slit for a distance of about 2 in., and the sigmoid attached to the fascia by 3 or 4 iron-dyed linen sutures. The abdomen is closed in the usual manner.

Colopexy.—The abdomen is opened by a median incision. The sigmoid is lifted out of the abdomen until it is taut. An incision is made in the peritoneum about 2½ in. long, beginning ½ in. from the original longitudinal opening in the peritoneum and running obliquely upward and outward toward the left kidney. Three or 4 sutures (preferably iron-dyed linen, small size), about ½ in. apart and embracing half the circumference of the bowel, are taken through the longitudinal muscular band of the intestine and then passed through the transversalis fascia. By this operation the sigmoid is firmly sutured to the transversalis fascia of the abdominal wall, thus preventing any further prolapse.

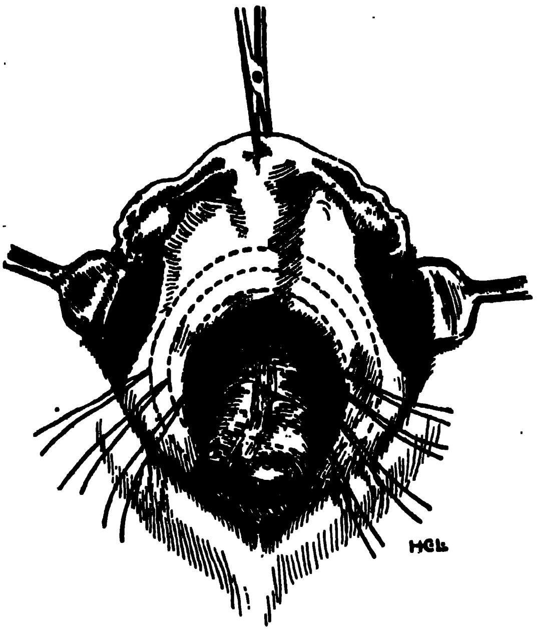

FIG. 20.—QUENU-MOSCHCOWITZ METHOD OF CLOSING THE CULDESAC IN PROLAPSE OF THE RECTUM.

Obliteration of Culdesac (Moschcowitz).—The operation of Dr. Moschcowitz presupposes that the prolapse is a true hernia. This is so only in a limited number of cases. In November, 1912, he suggested the following operation: Iron-dyed silk or linen sutures are passed circularly around the culdesac of Douglas and tied. By this method the sac is obliterated (Fig. 20).

Excision of the Rectum.—My own operation (4) is as follows: The patient being in the lithotomy position, with hips well elevated, the prolapse is dragged down as far as possible with traction forceps. It is then clamped by 2 volsellæ and held in this position by assistants. The elevated position of the hips allows the coils of small intestine to slip out of the peritoneal pouch, thus avoiding the danger of wounding them. After the intestine is dragged down, it is surgically cleansed and dried by sterile gauze. Sterilized gauze is now used to pack the gut in order to avoid soiling the wound. After these preparations, an incision is made through the mucous membrane, about an inch from the skin, upon the anterior surface of the gut. Dissection is carefully carried through the entire thickness of the intestine, all bleeding being checked as it occurs, until the peritoneal cavity is opened. Here Cunningham uses a clamp, which is an improvement on Mikulicz's method. When this is done, the serous membrane of the intussuscepted portion of the gut is brought into view. This membrane is cut through, and its upper edge sutured to the peritoneal edge of the wound in the anterior layer of the prolapse. Thus, step by step, the peritoneal pouch is closed. This having been accomplished, the entire thickness of the intussuscepted gut is cut through little by little, and its muscular and mucous layers sutured by chromicized catgut to the mucous membrane surrounding the margin of the anus at the site of the original incision.

In this manner the entire prolapse is excised, and end-to-end union of the gut accomplished. The ends of the sutures in the muscular and mucous layers are left long, in order to steady the parts and prevent their retraction while the operation on the other portion of the circumference is being made. All bleeding points are caught and either twisted or ligated during the operation. It should be noted that if, after completing the excision, the edges of the mucous membrane are not in accurate apposition, a continuous suture should be applied half way around the gut and tied, the other half of the gut afterward being treated in the same manner (a complete continuous suture is apt to cause contraction). The long ends of the sutures should then be cut off and the wound dusted with boric acid or thymol iodid. The operation having been completed, the gauze is removed, a Lynch's tube introduced, and the buttocks strapped with adhesive plaster to prevent the tube from coming out.

STRICTURE OF THE RECTUM

Stricture of the rectum is an occlusion of the bowel, either partial or complete, due to many causes. The occlusion may be valvular or tubular. Strictures usually occur within the first 3½ in. of the canal, but the extent of the occlusion is influenced by the etiological factors concerned. For instance, syphilitic strictures may involve not alone the rectum but the entire colon. Such cases have come under my observation. Therefore, in treating stricture we must be guided by the location and extent of the involvement. Stricture of the anus following operations or some suppurative process can in the majority of cases be cured by systematic dilatation. Valvular stricture may be cut or dilated, but with tubular strictures, especially where the stricture is above the peritoneal reflection, a very conservative method should be adopted, otherwise serious results may follow. We have known of more than one case where the use of mechanical instruments has resulted in a rupture of the bowel seriously endangering the patient's life; and in cases that have come under my observation the patients have been saved only by promptly opening the abdomen and repairing the damage. **We sound this note of warning so that those who are in the habit of using mechanical instruments, or instruments of any kind where the pressure cannot be estimated, may consider the danger.**

Symptoms.—The patients usually give a history of diarrhea during childhood or adolescence. Gradually increasing constipation was probably the first symptom that attracted the patient's attention. Simple cathartics were effective at first, but after a while they failed to give the desired relief and the patient had to resort to enemata and stronger cathartics. As time went on, colicky pains became more frequent and the patient had constipation alternating with diarrhea, and a desire to move the bowels frequently, followed by a discharge of mucus, blood, and pus, and a feeling of insufficient stool. Frequently urination is associated with stricture and is due to the pull exerted on the peritoneum as it passes from the bladder to the rectum.

In some cases of stricture of the rectum most of the symptoms are referred to the stomach. I saw one case where the woman complained of diarrhea, pain after eating, eructations of gas, and an uncomfortable feeling in the stomach. She was treated for her stomach for a number of years, and was finally referred to me by a stomach specialist. After appropriate treatment for the stricture had been properly carried out, the dyspepsia entirely disappeared.

Local Treatment.—The treatment of stricture may be divided into local and operative. When the stricture is seen fairly early, or before the caliber of the gut is so diminished that bougies or a proctoscope cannot be passed, many cases can be permanently benefited by irrigating the rectum with one of the following solutions: Permanganate of potash, 1:10,000; peroxid of hydrogen 2 per cent., with the internal administration of Russian mineral oil to keep the bowel contents liquid. Passing the proctoscope and painting the ulcerations with tincture of iodin are most beneficial. One should, however, be careful not to paint too large an area at any one time, as severe tesesmus may follow the too lavish application of iodin. If iodin does cause tenesmus, an enema of starch will quiet the bowel within a short time.

Gradual Dilatation.—This is the method usually employed by surgeons and is carried out by means of bougies, dilators, and numerous devices that have been suggested or specially devised for some particular case, beside graduated bougies, such as the Wales's bougie. All are dangerous. It should be remembered in dilating strictures that one has to deal with a friable bowel wall and that if by any chance it is overstretched it will always rupture in the long axis of the gut. A stricture near the peritoneal reflection means that the bowel will rupture into the peritoneal cavity. When the stricture is near the anus or below the peritoneal reflection, however, there is very little danger of doing any damage. So that dilatation in this region is a comparatively safe procedure. There is, however, some danger when metal instruments are employed as the prostate and urethra may be seriously damaged by such instruments.

I believe that if a stricture cannot be dilated by a rubber bougie or a small-sized proctoscope, where the operator can see what he is doing, it is very much better to perform a colostomy rather than risk a rupture of the bowel by trying to dilate the stricture.

Where the stricture is high up, there is always a sagging of the bowel. For this reason some difficulty may be experienced in introducing the proctoscope. It may be passed into the sulcus around the prolapsed bowel, and, if force is used, to the bowel limit. For this reason it is always safer to pass the proctoscope up to the stricture and introduce the bougie through the proctoscope into the opening in the stricture. After the bougie has been introduced, the proctoscope can be withdrawn and the dilatation continued.

Posterior Proctotomy.—This operation relieves only for a short time, and if the dilatation is not kept up after the proctotomy, the condition is aggravated rather than relieved. The patient is prepared in the usual manner for a surgical operation and the bowels cleaned out for some days previous.

The patient under an anesthetic is placed in the lithotomy position, the sphincters are dilated, and an incision is made through all the coats of the bowel posteriorly back to the sacrum above and through the sphincters along the side of the coccyx and sacrum until the most dependent point is reached. This is necessary in order to establish through drainage.

The cavity is packed with iodoform gauze and a drainage tube inserted. On the third day after the operation the gauze is removed and the cavity washed out with a normal salt solution. The cavity is kept packed for several weeks after operation, the object being to prevent granulations from forming at the bottom and if possible allow the mucous membrane to dip down into the cavity, as by this means the caliber of the bowel is considerably increased. Dilatation should be systematically kept up for several years afterward.

Excision.—Very excellent results follow this operation, but the mortality is high, almost as high as in carcinoma. For this reason, one should hesitate before suggesting a radical operation for stricture. A radical operation is out of the question if the stricture is specific. It has been my experience that when the stricture is specific there is always an involvement of the greater part of the colon and that, though a radical operation may temporarily give relief, the foundation for another stricture has already been laid. This has been demonstrated by making sections at various distances from the stricture, and in those cases where there was an opportunity to examine the bowel histologically changes were always found which would sooner or later lead to the formation of a stricture.

For this reason a Wassermann reaction should be made in all cases of stricture in order to determine whether the stricture is specific or not. We are aware that the Wassermann reaction may not always be a means of making a positive diagnosis, but at least it is the best we have at our command at the present time.

One must also consider the fact that, even though the patient may get relief from the stricture, the question of continence must always be considered. Very few cases where the stricture has been excised have had perfect continence after operation.

PERINEAL METHOD.—No one method is applicable to all cases. When the stricture is situated within 3 in. of the anus, the perineal method is the safest and best operation, provided, of course, the sigmoid is sufficiently long so that it can be brought down to the anus without tension. The technic differs in no respect from that which is described in the chapter on cancer. The mucous membrane is dissected off from the anus, is well cauterized, and closed by a silk suture to prevent soiling of the wound with the introduction of the finger into the rectum during operation. The sphincters are incised in the median line back to the tip of the coccyx, and the incision continued through the levator muscle. After the levator muscle has been incised, the index finger is passed around back above the levator muscle and the levator is cut free from the rectum. The hand is passed into the opening in the levator muscle and rectum gradually separated up as far as the promontory of the sacrum. The sphincter muscle is divided anteriorly and, with the sound in the urethra, the rectum is gradually dissected anteriorly from the urethra and prostate until the peritoneal reflection is reached. The lateral ligaments are now doubly clamped to prevent hemorrhage from the middle hemorrhoidal arteries. After this has been done, the surgeon proceeds to cut between the clamps. The dissection is carried on both sides as high as the peritoneal reflection and the lateral peritoneal attachments are divided. The rectum should now be delivered with ease unless there are some other attachments. If there are any, they are divided. Force should not be used to bring the sigmoid down, as in so doing the superior hemorrhoidal artery is injured and profuse hemorrhage will result. It may be necessary to open the culdesac in front, but in most cases it can be peeled back until the gut comes down without tension. If it is necessary to cut it the packing should be immediately inserted to prevent the small intestine from coming down into the wound.

The stricture having been delivered and sufficient healthy gut brought down to permit of suture without tension, the culdesac is closed by interrupted catgut sutures and the levator muscle stitched to the side of the bowel. All dead spaces should be closed with interrupted catgut sutures. The sphincter is now sutured anteriorly and posteriorly, and a few interrupted catgut sutures are inserted on either side to prevent traction of the bowel. The bowel is divided above the stricture and the mucous membrane is stitched to the mucocutaneous surface. A drainage tube around which some gauze has been packed is inserted into the posterior wound and allowed to remain in place for 24 hours. A drainage tube is also inserted through the rectum, and the patient returned to bed.

SACRAL METHOD.—This consists in some modification of the Kraske operation. Some remove the coccyx and part of the sacrum; others prefer the bone-flap operation. They believe that the peritoneal operation answers every purpose. If the stricture extends above the peritoneal reflection, then the combined operation, such as that employed by me, has been found more satisfactory than any modification of the Kraske operation. The great drawback to the combined operation is that the mortality is particularly high in men and I believe that patients should always be given a choice of methods before attempting to employ a radical operation.

Artificial Anus.—I believe that a stricture of the tubular type, no matter from what cause, can best be relieved by means of an artificial anus. Whether this is temporary or permanent will depend to a great extent on the etiology of the stricture and the amount of involvement. The question as to the location of the opening must be determined beforehand, because if the surgeon should subsequently decide to remove the stricture the fixation of the sigmoid might prove a source of embarrassment as some difficulty might be experienced in bringing down the sigmoid to the anus. It is, therefore, better, if one has not decided to make a permanent opening, to make it either in the transverse colon or in the lower portion of the ileum. By this method no subsequent embarrassment will result if the surgeon later decides to perform the radical operation.

PRURITUS ANI

Pruritus ani is an exceedingly common and distressing malady. As a general rule, it yields to local treatment, but when this treatment fails, recourse must be had to operative measures. The most satisfactory operation for the relief of pruritus ani is one that affords relief but at the same time is free from danger. Several procedures have been devised, notably Ball's and Krause's.

Ball's Procedure.—The skin having been cleansed as completely as possible, a curved incision is made on each side of the affected area (Fig. 21), inclosing the entire ellipse, with the exception of a narrow neck in front and behind. These incisions are carried down to the sphincter muscle, and the flaps raised, by careful dissection with scissors, from the surface of the muscle, around its anal margin, and up the anal canal to above the mucocutaneous junction, the dissection extending around the entire circumference, all connections with the subjacent tissues being divided. The pedicles in front and behind are now undercut to a point well beyond the area of irritation and the outer concave edges of the incision also undercut to a distance of at least ¼ in. free of the involved skin all around. Care must be taken to stop all bleeding and the flaps should not be replaced until it is completely arrested, as the formation of a hematoma in the wound may compromise the vitality of the flaps. The flaps are finally replaced and retained by sutures, a few intervals being left between them for drainage.

The immediate result of this operation is to render the entire ellipse included between the incision, the pedicles, and outer edges as far as they have been undercut, superficially anesthetic, and the itching is at once relieved. The first case operated on in this manner occurred 5 years ago. Except for slight superficial vesication upon one side of the flap, healing was rapid. Cutaneous sensation returned some months after the operation, but by this time the skin had become so altered that the pruritus did not return and the patient had not had a moment's trouble with itching since. His case had been an extremely severe one, of 16 years' duration, and his life was so miserable that he threatened suicide if he could not be relieved.

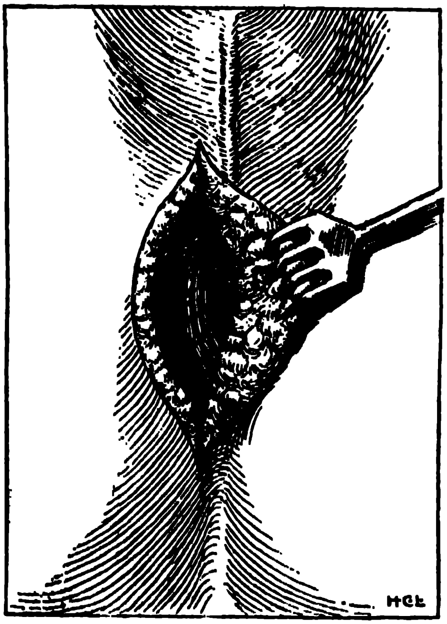

FIG. 21.—THE CHARLES BALL OPERATION FOR PRURITUS ANI.

I have now operated 14 times by this method and in all of them there was immediate relief; in no case did the vitality of the flaps suffer, and in none of them has there been any return of pruritus in the area dealt with, even after the return of normal sensation. Two cases came back asking for treatment of small spots of irritation over the tip of the coccyx, which had escaped the previous operation; both were dealt with by raising and replacing a small flap of skin which included the affected spot. On one occasion I dealt similarly with a localized patch of pruritus, with marked trophic changes in the front of the vulva, with equally satisfactory results. Since the first notes of this operation for pruritus ani were published (1), I have received information from several surgeons that they have adopted the procedure with uniformly satisfactory results.

Krause's Operation.—Krause's operation differs from Ball's in that, instead of making 2 elliptical incisions, he makes 6 linear incisions radiating from the anus and following the course of a circle whose center is the anal canal (Fig. 22). One incision is anterior, one is posterior, and 2 are lateral. The skin between these folds is dissected up so that the sensory nerves are temporarily severed. The advantage he claims for his operation over Ball's, is that the blood supply of the flap is not impaired in his operation, whereas in Ball's there might be some difficulty of this kind. In some 20 operations that I have performed I have never had the slightest sloughing or anything that would suggest nutritional disturbances of the flap. Primary union has occurred in all cases.

Author's Method.—I believe that the method detailed below, as devised by myself, has all the advantages and none of the disadvantages of the other operations. The entire operation is performed under local anesthesia and in no way inconveniences the patient or enforces confinement. It is not beset with possible complications as are the other procedures; there is a minimum amount of scar formation, and the direction of the scar makes stricture impossible; while the blood supply of the operated area is so little disturbed that the danger of sloughing is nil.

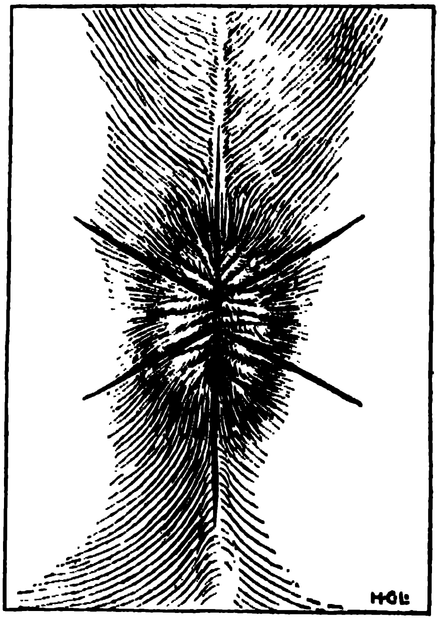

Fig. 22.—Louis J. Krause's Operation for Pruritus Ani.

The patient is placed upon his left side, with knees and thighs flexed. At a point about 1¼ in. from the anus a 1 per cent. solution of novocain or a ⅕ per cent. solution of cocain is injected (Fig. 23). (More recently we have preferred a 2 per cent. solution of hemesia.) An area extending to the posterior midline is anesthetized. At the point above mentioned a small curved incision is made, about ½ in. long, and extending just through the skin (Fig. 24). Through this incision a blunt-pointed dissecting scissors, curved on the flat, is introduced (Fig. 23). With this instrument, a blunt subcutaneous dissection is now carried out, working to the anus mesially, and to the raphés anteriorly and posteriorly. When completed, there is an area of skin, extending from the anterior raphé to the posterior commissure and involving all the skin within a radius of 1½ in. from the anus, which has been deprived of its sensory nerves. Any bleeding may be controlled by pressure. When the bleeding has stopped, a small piece of rubber tissue is introduced into the incision and permitted to remain for 12 to 24 hours. Sometimes in addition a horse-hair stitch is taken through the incision; but this is not usually necessary. As a rule, at the end of 48 hours, the wound is entirely healed. Either at the same sitting, or at some subsequent time, the same procedure is followed on the other side. The results of this operation have always been satisfactory.

Though there may be a recurrence, this is not likely to take place for 2 or 3 years, and 2 or 3 years of relief to a patient is often a great boon. The itching, of course, ceases immediately and, perineal sensation being lost, the irritation soon lessens. With proper treatment all local conditions should promptly clear up.

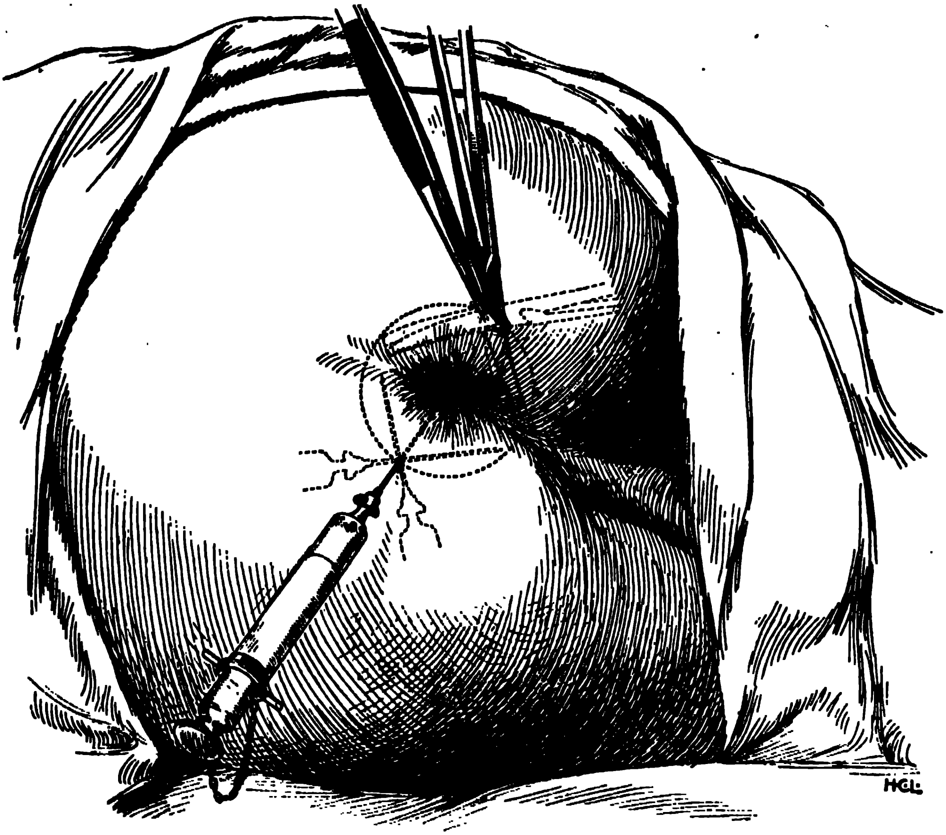

FIG. 23.—LYNCH'S OPERATION FOR PRURITUS ANI.

CRYPTITIS

At the termination of the anal mucous membrane there are a number of longitudinal folds. Between each series of folds is a depression which dips down and forms a little pocket. These pockets are known as the crypts of Morgagni. Occasionally, foreign bodies of small particles of fecal matter collect in these pockets and cause ulceration, which may or may not result in abscess formation.

Symptoms.—Pain is the most constant symptom of cryptitis; usually dull and aching in character, it is constantly annoying the patient. Sometimes the pain is sharp and shooting in character, throbbing when an abscess starts to develop. The pain is increased during defecation, is worse after violent exercise and is aggravated by occupations which require the individual to stand for a long time. Occasionally the pain is referred to the prostate in males. Spasmodic stricture is nearly always present. Other symptoms which may be present are painful urination, dysuria, mucous urethritis, neuralgia of the testicles, and perineum and spasm of the levator ani.

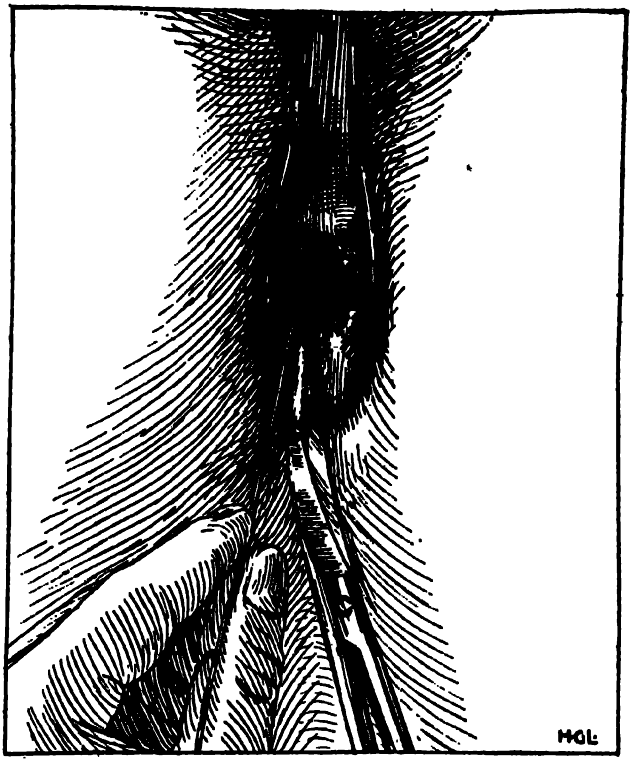

FIG. 24.—LYNCH'S METHOD OF TREATING CRYPTITIS.

Diagnosis.—The diagnosis is made from the symptoms and from direct examination, a procedure performed as follows: A Humphrey's or similar speculum having been passed, a probe with its point bent like a shepherd's crook is inserted into the rectum and each crypt probed. Very little pressure should be employed, as the mucous membrane tears very easily. If an inflamed crypt is present, the patient will experience severe pain the moment the probe is inserted. This pain greatly resembles the pain experienced when the exposed nerve of a tooth is probed.

Treatment.—If cryptitis is recognized in its early stages, it can be cured without operation. A speculum is inserted into the rectum in such a way that the crypt readily comes into view and is accessible. A bent probe, such as the one used in examination, is dipped into pure ichthyol and then introduced into the crypt, thus applying the ichthyol directly to the ulcerated area. This process is repeated daily until all the pain has disappeared. If surgical interference should prove necessary, the operation can be performed under local or general anesthesia. If local anesthesia is used, the sphincter is first anesthetized. After this has been done, a Humphrey speculum is introduced in such a way that the crypt lies in full view. The crypt to be operated upon is infiltrated with whatever local anesthetic is being employed and a probe introduced into the crypt. Tension is then exerted on the probe and with a scissors, curved on the flat, the entire valve and crypt are excised. (Fig. 24.) The sphincter is gently stretched and a small piece of iodoform gauze inserted over the cut surface. A Lynch tube may be inserted and permitted to remain for 48 hours. At the end of this time the bowels are moved and a 2 per cent. peroxid enema given before and after the bowel movement. The after-treatment consists in making local applications of ichthyol or silver nitrate to the raw surface as indicated until it is entirely healed.

TUMORS

Different types of benign tumors are found in the rectum, sigmoid, and colon (Fig. 25). In fact, they are more frequently found in this region than any other portion of the intestinal tract. One type of tumor, the adenoma, is sometimes found in the stomach; but not as frequently as in the large intestine. All benign tumors are potential cancers and it is difficult for anyone to say how long the cells composing them will refrain from anarchy in growth. Therefore, their prompt removal when discovered is the surest means of avoiding future trouble. Besides, innocent tumors in the gastrointestinal tract are a constant source of danger in causing intestinal obstruction, intussusception, volvulus, obstruction to the circulation of the bowel, diarrhea, and constipation. The adenoma or glandular innocent tumors when single are usually pedunculated (Fig. 25); when multiple they are sessile (Fig. 25). Some authorities try to make a distinction between tumors found in children and those that are found in older people. Of course there is some distinction in that the glandular tissue is less in children than in grown people. Otherwise there is no distinction. Single growths are usually situated in the rectum but may occur in any part of the intestinal tract; multiple growths usually involve the entire colon. Malignant degeneration occurs more frequently in multiple than in single growths. The reason is apparent. In young children the first symptoms to attract the attention of the mother is fretfulness. In addition to this the following symptoms are characteristic: straining and crying when the child sits on the toilet, with the passage of mucus and blood. Diarrhea may occur, the child may have a frequent desire to move the bowels and may pass clotted blood or fresh blood with the mucus. Severe hemorrhages occasionally result. In older individuals there are a feel-

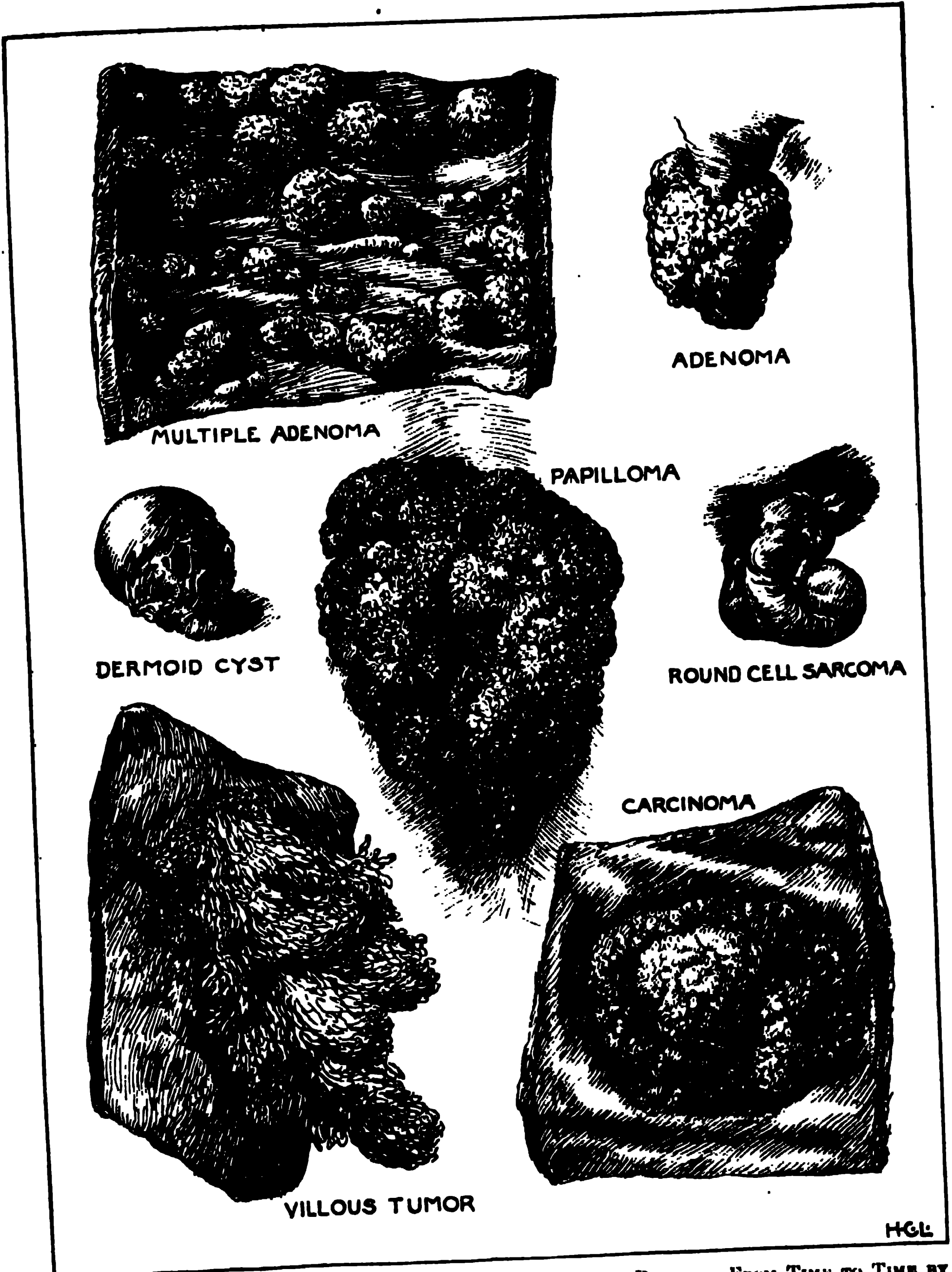

FIG. 25.—DRAWINGS FROM VARIOUS TUMORS THAT HAVE BEEN REMOVED FROM TIME TO TIME BY THE AUTHORS.

ing of unfinished stool, bloating, and the frequent passage of gas. The feces are usually streaked with blood. Constipation is more frequent in the multiple type than diarrhea.

Treatment.—When the tumors are situated in the rectum and within reach of the proctoscope, they can be removed by fulguration or by the snare. When they are multiple, they usually involve the entire colon and the only treatment that has given any success is that which I have followed for a number of years, namely, short-circuiting the colon, performing an ileostomy and putting the colon absolutely at rest. The most prominent symptoms in the multiple type are intermittent diarrhea and constipation with mucus and blood in the stools, abdominal pain and tenderness. A solution of tannic acid, 2 per cent., has been found useful. This may cause griping pain, but the pain disappears after the passage of the contents of the bowel. When irrigations of tannic acid cause severe cramps, tenesmus or bleeding, it should be temporarily stopped and normal salt solution substituted. The salicylate of bismuth, 20 gr. to a pint of water, seems to be the most efficacious. The ileostomy should be allowed to remain open for 2 years. At the end of this time implantation of the ileum into the sigmoid seems to give the best results and prevent recurrence of the trouble.

Myoma.—This is rather a rare growth in the intestinal tract. The symptoms depend on the location of the tumor, but in the majority of cases pressure on some nerve or neighboring organ is the first symptom to attract the attention of the patient. If allowed to go untreated, it usually causes intestinal obstruction. *Treatment* should be the removal of the tumor at the earliest possible date.

Fibroma.—Fibromata are usually found around the hemorrhoidal area and they are usually pedunculated. The chief symptom is tenesmus, with a desire to move the bowels. When situated in the anus they can be removed by the clamp and cautery; if higher up by the snare.

Papilloma.—Papillomata may occur around the anus or involve the rectum and colon (Fig. 25). When outside of the anus, they usually attain a very large size. Inside, they are of soft consistency and pedunculated, occasionally sessile. They usually consist of connective tissue, stroma and a number of blood-vessels and are infiltrated with round and partly spindle-shaped lymph or inflammatory corpuscles. The most frequent symptom is the large amount of glairy mucus which is passed. The bowels are usually constipated or the patient has a desire to empty the bowel, with the passage of large quantities of mucus. Hemorrhage is variable. Sometimes large amounts of blood are passed; sometimes the mucus is simply blood-tinged.

TREATMENT.—As these tumors are more apt to become malignant than any other of the so-called benign tumors they should be radically removed, as one can never tell when such a tumor is benign and when it is malignant. It is, therefore, better to treat them as malignant tumors and remove the gut entire, rather than remove merely the tumor itself with the mucous membrane, though such a procedure may at times give good results when the tumor has not undergone malignant degeneration. To remove only a part of the tumor with the mucous membrane may result satisfactorily, but as a general rule it is much safer to remove the entire bowel than take the chance of recurrence. When the tumor is of a very small size and pedunculated, it can be easily removed by means of a snare, by tying the pedicle, or by the cautery. It may require a careful histological examination to see that it has not degenerated.

Cystoma.—This is a term used to indicate a certain type of tumor which is the result of cystic degeneration. An ordinary tumor may be an adenoma, a fibroma or a simple cyst. Simple cysts are comparatively infrequent in the rectum. When present, they may be found either at the anus or in the posterior wall of the rectum. When found, radical removal is the only treatment. Sacrococcygeal tumors usually occur in the anterior surface of the sacrum and coccyx and may be mistaken for tumors of the rectum per se. When found, they can be radically removed, as they are very frequently malignant and must be of the sarcomatous type.

Angioma or Nevus Tumors.—These are dilated venous capillaries bound together by connective tissue. They are sometimes mistaken for hemorrhoids and if treated as ordinary hemorrhoids the result is apt to be fatal. They are usually of a purplish hue, the skin is very much thickened, and the appearance is entirely different from that of an ordinary hemorrhoid, so that the mistake should not be made. Electrolysis is probably the safest procedure to employ in such a condition. Most of the cases that have been operated on by the knife have resulted fatally.

POSTANAL DIMPLE·

Postanal dimple is sometimes spoken of as sacrococcygeal sinus. A postanal dermoid is a dimple-like infolding of the skin, of congenital origin, due to the imperfect approximation of the lateral halves of the body. It is frequently seen in the new-born child, and usually marks the point at which the coccyx disappears below the surface, about the third month of fetal life. This is correlated with the division of the cloaca and the formation of a permanent anus. The opening is funnel-shaped and varies in depth. It is lined with stratified squamous epithelium, and differs from normal skin only in possessing nerve bulbs, sweat or sebaceous glands. These dimples usually appear in hairy people, and the 51 or 52 cases which have come under my observation have all been males. I have never observed this irregularity in females. In a report of 31 cases by Giffon and Archibald 2 were in females (2).

This condition of sacrococcygeal tumor must not be mistaken for the tumors occurring in the anterior or ventral aspect of the coccyx. These tumors are derived from the coccyx body, which is composed of cells analogous to the superrenal. By this we mean that they are composed of cells which have an affinity for chromic acid, hence the name. They are closely associated with the sympathetic nervous system. The condition must also be differentiated from the anal coccygeal tumor or cyst which rises from the remnants of the neurenteric anal cells from the remains of the postanal gut, and from ordinary fistulæ, or fistulæ of tuberculous or syphilitic origin.

I lay stress on this point, as, from past experience, I know that such mistakes frequently occur. One such instance, in particular, I have related in my book on "Diseases of the Rectum and Colon" (5). A patient, who had contracted syphilis early in

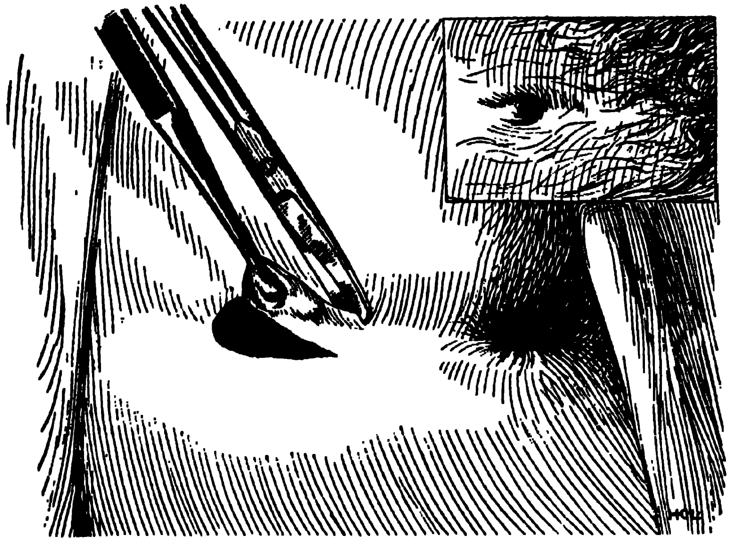

FIG. 26.—LYNCH'S METHOD OF TREATING A POSTANAL DIMPLE.

life, developed this suppuration in a postanal dimple, and though operated on many times, still had an opening. The symptoms are those of an abscess or a chronic suppurating sinus between the folds of the back.

The treatment is nearly always surgical; at least, this gives the most satisfactory results.

Instruments Used.—The instruments used in this operation are a hypodermic syringe, half a dozen artery forceps, a knife, scissors curved on the flat, 2 thumb forceps, and a couple of curved needles threaded with silkworm-gut. The George D. Stewart stitch is of inestimable value.

Author's Method.—The fistula having been thoroughly irrigated with peroxid of hydrogen, and afterward with pure iodin, the skin is painted with tincture of iodin just before the operation. Hemesia is an ideal anesthetic for these cases. Ethyl chlorid is sprayed on the skin about ½ in. from the dimple, which permits of the introduction of the needle without pain. The skin and deep tissues are now thoroughly anesthetized all around, and about ¼ in. from the wound. By applying this procedure, the infected fistula may be removed in toto, and subsequent sloughing avoided, the wound healing occasionally by primary union. An elliptical incision is made around the area to be removed (Figure 26 reveals the method of removing the dimple).

The skin is grasped with a mouse-toothed forceps, and the entire mass removed without invading the infected tissue. A rubber drain is inserted, and the wound is closed by a George D. Stewart stitch. The dressing should be removed after 24 hours.

After-treatment.—The after-treatment consists in dressing the wound every day. If there is any evidence of suppuration, the silkworm stitches should be removed, and the wound allowed to heal by granulation. We know of no surgical condition that terminates so satisfactorily as does the operation for the relief of postanal dimple.

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OPERATIONS UPON THE KIDNEY, RENAL PELVIS, ETC.

CHAPTER XII

OPERATIONS UPON THE KIDNEY, RENAL PELVIS, ETC.

FRANCIS C. EDGERTON

SURGICAL ANATOMY

Size and Position.—The kidneys, 1 on either side of the spine, lie deeply placed retroperitoneally in what has been variously termed the lumbar fossa, iliocostal space, or costovertebral angle. Normally they cannot be palpated, except the lower end of the right kidney in some cases. The kidney measures about 4 in. in length, 2½ in. in its transverse axis, and 1¼ to 1½ in. in thickness. Roughly the kidneys may be said to lie along the sides of the last dorsal and upper 3 lumbar vertebræ, although this in reality applies only to the right, the left lying about ½ in. higher and extending from the level of the lower end of the eleventh thoracic spine to a little below the second lumbar spine.

Anteriorly a vertical line, perpendicular to the middle of Poupart's ligament, cuts the kidney longitudinally so that ⅓ lies to the outer side and ⅔ to the inner side of this line. A horizontal line through the lowest joints of the tenth costal cartilages cuts the lower ends of the kidneys. Hence the kidneys are found mainly in the epigastric and hypochondriac regions, and only in small part in the umbilical and lumbar regions, where they are often incorrectly thought of as being (Woolsey). On the posterior surface of the body the kidney may be mapped out in a parallelogram, the inner side of which is a line parallel with and 1 in. from the spine extending from the level of the lower edge of the tip of the spinous process of the eleventh dorsal vertebra to the lower edge of the spinous process of the third lumbar vertebra; the outer side is made by a line parallel to the first and 2¾ in. from it. It is here seen

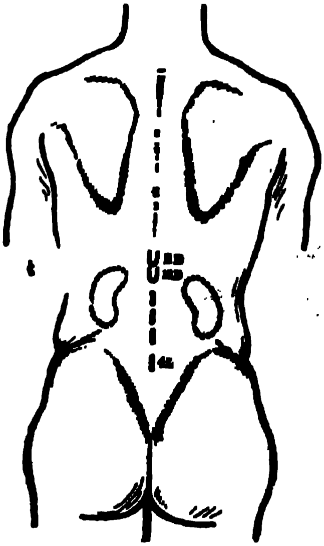


FIG. 1.—RELATIVE POSITION OF KIDNEYS TO THE POSTERIOR SURFACE OF THE BODY.

that the kidneys approach the surface most nearly below the twelfth rib and to the outer side of the erector spinæ muscle, but unless considerably enlarged by disease or by reason of involvement of the retrorenal fat, a fullness in this costo-iliac region is not observed; similarly, absence of the kidney produces no sensible depression here. In the above parallelogram, the upper ends of the kidneys about correspond to the interchondral articulation of the sixth and seventh costal cartilages. From here the axis slopes downward and outward to a level about 1 in. above the umbilicus, bringing the lower pole of the kidney about 1 in. further from the mid-line than the upper.

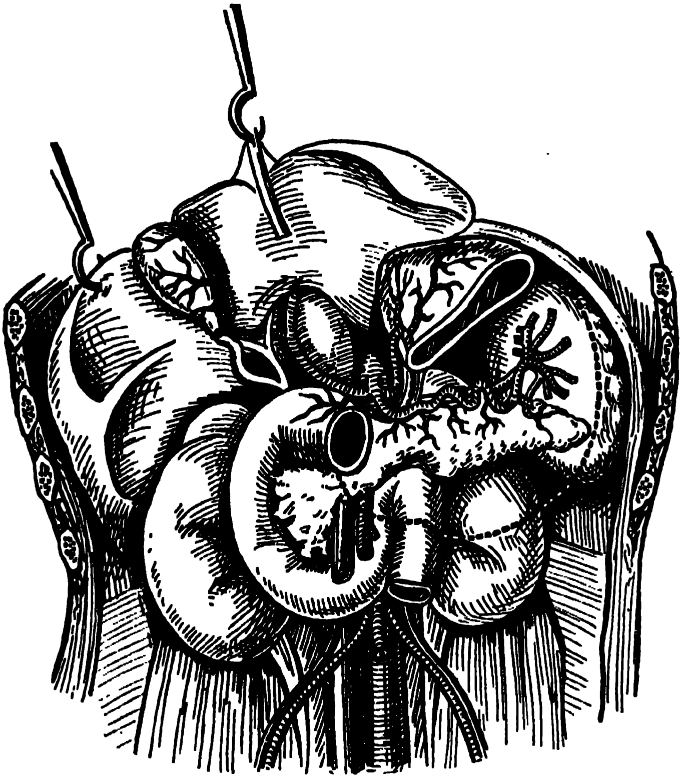


FIG. 2.—VISCERA OF UPPER PART OF ABDOMEN. The liver is lifted up showing the gall-bladder and the upper part of the gall ducts.

Visceral Relations.—The visceral relations of the 2 kidneys, important in nephrectomy, differ on the 2 sides. Anteriorly the *right kidney* is in relation in the upper half to the liver, the descending portion of the duodenum along the inner margin, and the ascending colon in the lower half. Close to the inner border lies the inferior vena cava. This relation to the duodenum and ascending colon may be useful in explaining the initiation of gastroptosis and of chronic appendicitis by a right nephroptosis.

The *left kidney* has in front of it the fundus of the stomach in the upper third, the splenic vessels and end of the pancreas in the middle third, the descending colon in the outer part of the lower third, while along the upper half of the outer border lies the spleen. The inner border is an inch or more from the aorta. Abscess of or about the kidney may involve the lower spleen or pancreas, or perforate into the colon, duodenum, or stomach. With tumors of the kidney, the colon may retain its position and resonance in front of the kidney or may be deflected inwardly, leaving a continuous area of dullness in the flank and posteriorly.

Posteriorly the kidneys lie upon the diaphragm above, the outer border of the psoas, the quadratus lumborum, and transversalis, each covered by its fascia below. The twelfth rib crosses the position of the kidney in such a way that ⅓ or more of the organ is above it, more on the left side than the right, owing to the higher position of the left kidney, whose upper pole is overlapped by the eleventh rib. This relation on either side is of great importance, as the kidney is here in close relation, through the diaphragm, to the pleura, whose lower limit on either side extends nearly horizontally from the lower border of the twelfth thoracic vertebra, meeting the twelfth rib about 3½ in. from the median line and the eleventh rib 2 in. further laterally (Woolsey). In resection of this rib for more room, care must be used; similarly should this rib be absent it is important not to mistake the eleventh rib for it. The tips of the transverse processes of the first and second lumbar vertebræ overlap both kidneys along the mesial border, the first lumbar at about the level of the hilum. Lying between the kidney and the quadratus lumborum are the last thoracic nerve, which is a good guide to the lower end of the diaphragm, the ilio-inguinal and iliohypogastric nerves, and the first lumbar vessels. Later consideration will be given these nerves in connection with incisions through the lumbar route.

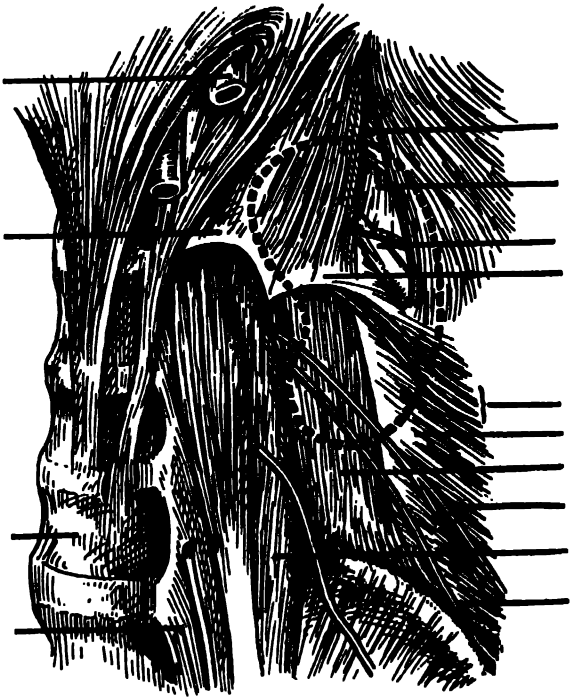


Fig. 3.—Position of Kidney with Reference to Posterior Abdominal Wall. The dotted line represents the position of the left kidney.

The viscera in relation to the anterior surface of the kidney, with the exception of the liver and stomach, intervene between the kidney and the peritoneum so that the latter covers only a limited area of the anterior renal surface, somewhat greater in the right kidney than the left. The peritoneum covering the left kidney is derived from that of both the lesser and greater peritoneal sacs. Lying behind the peritoneum as it does, lumbar incision forms the method of choice for most operations upon the kidney. This also explains why injuries of the kidney are mostly extraperitoneal in their symptomatology and on this account less serious than corresponding injuries of the intraperitoneal viscera.

The Kidney Pedicle.—The hilum of the kidney, lying at the level of the first lumbar vertebra, looks forward, inward, and somewhat downward, bringing the thicker posterior lips somewhat nearer to the median line. Into this aperture enter or emerge the structures constituting the pedicle of the kidney. Of these the vein lies in front, the artery between, and the ureter and pelvis behind and somewhat below, making the pelvis of the kidney most accessible from behind. In addition there are a large number of lymphatics, a quantity of connective tissue, and nerves derived from the renal plexus, which in turn is derived from the solar and aortic plexuses and the lesser splanchnic nerves. The renal plexus is closely associated with the spermatic plexus in the male, with the sympathetic ganglia supplying the intestine and bladder, and with the upper lumbar nerves, this association accounting in large part for the testicular pain, the intestinal and vesical tenesmus, and the lumbar radiations that so frequently accompany affections of the kidney. The renal artery is large beyond proportion to the size of the organ—about the size of the brachial. Owing to the position of the aorta, it is shorter on the left than on the right side, where it crosses behind the inferior vena cava. Before reaching the hilum or at the hilum of the kidney, each artery divides into from 2 to 5 branches, which, arranged in an anterior and posterior group, pass respectively to the ventral and dorsal halves of the kidney, entering its substance through the sinus as smaller branches which lie in the intervals between the pyramids—the interlobar arteries. The anterior group of these arteries lies in front of the pelvis of the ureter, the posterior group may pass behind. All lie behind corresponding branches of the vein. These arteries, however, are subject to variations in over 40 per cent. of cases, i. e., irregularities in number, in place of entry, in relations to surrounding structures, etc. Frequently an extra-aortic branch passes either to the hilum of the kidney or, most often, to its lower pole—a possibility to be borne in mind in ligation of the pedicle. Having entered the kidney, the interlobar arteries of the anterior and posterior group are essentially end arteries and do not anastomose extensively, dividing the kidney into anterior and posterior halves, each of practically independent blood-supply and the anterior somewhat larger than the posterior half in 4/5 of cases.

Between this anterior and posterior vascular division lies the exsanguinated renal zone of Hyrtl or avascular zone of Brödel, usually about 2/5 in. posterior to the convex border of the kidneys. It is through this zone that the kidney is usually incised in nephrotomy or nephrolithotomy. In about a fifth of the cases this zone may lie anterior to the convex border. The relative position of the zone may be recognized roughly by the fact that, when posterior, the kidneys show rounded in front with pulsating arteries at the anterior hilum, the posterior surface is flat and shows deep notching in which the pelvis lies. The deeper this notch, the further posterior is the vascular division (Cullen and Derge). Accompanying the arteries in their divisions are the renal veins in front. Owing to the proximity of the ascending cava to the ureteral pelvis on the right side, the vein here is very short and requires particularly careful manipulation in removing the organ from this side. It has frequently been torn. For the same reason, thrombosis of the inferior cava of neoplastic origin from the right kidney is more prone to occur. The left renal vein has emptying into it the spermatic vein of the same side.

The Ureters and Ureteral Pelvis.—The pelvis of the ureter, composed usually by the junction of a smaller upper part from the superior pole and a larger lower part from the inferior 3/5 of the organ, lies partly intrarenal, but mostly extrarenal at the posterior inferior part of the kidney pedicle. It narrows as it descends and becomes the ureter proper opposite the lower pole of the kidney. From here the ureters, about 12 in. in length and 1/5 in. in caliber, converge as they descend retroperitoneally to the brim of the pelvis, which they cross near the sacro-iliac joints at points about 2 in. apart. In this course they lie on the psoas muscle, and cross the genitocrural nerve and the common or external iliac artery at the brim of the pelvis. They then follow the curve of the posterior pelvic wall, about parallel with the sides of the sacrum, and cross the external iliac artery to a point about level with the spine of the ischium. From here on the course differs in the male and female. In the male, the ureters lie in the parietal attachment of the posterior false ligament of the bladder, running forward and inward and entering the base of the bladder in front of the apex of the seminal vesicle, about 1½ in. from its fellow of the opposite side and 1½ in. behind the prostate. In the female the ureter is surrounded by numerous veins from the uterine and vaginal plexuses; it lies in the base of the broad ligament, passes about ½ in. to the outer side of the lateral fornix of the vagina, inclines forward from the lateral vaginal wall to the vesicovaginal interspace, and terminates in the bladder opposite the middle of the front wall of the vagina. In this course, it is crossed in front by the uterine arteries at the level of and about ¾ in. distant from the cervix uteri. Both ureters traverse the wall of the bladder obliquely for about ¾ in. and open internally about 1 in. from each other. In their course they are adherent to the overlying peritoneum and strip up with it from the underlying muscles. They present, usually, 3 fairly constant constrictions. The first is about 2 in. from the pelvis of the kidney (Bruce Clark). The middle is at the point where the ureter crosses the iliac vessels, the third and narrowest is in its course through the bladder wall and orifice, where the circular fibers form a sphincter. The loose connective tissue surrounding the ureter is rich in lymphatic vessels, perhaps accounting *for the ascending course of tuberculosis primarily located in the genitalia of the male.*

The Kidney Capsule.—The kidney is surrounded by a closely fitting, thin, smooth, fibrous tunic, normally attached to the kidney substance only by minute capillary vessels and fine connective-tissue processes; hence, as a rule, stripping easily from the surface of the normal organ with little bleeding. This fibrous capsule is continuous at the sinus with the elastic tissues of the calyces and pelvis of the organ. About this capsule is a considerable layer of loose areolar tissue which, in adult life, usually contains a great deal of fat: this is the tunica adiposa or perirenal fatty capsule, and normally constitutes, with the intra-abdominal pressure, one of the main supports of the kidney. In addition to this, Zuckerkandl and Gerota have described a second or pararenal fatty layer which is a continuation of the subperitoneal fascia of the abdominal wall. At the outer border of the kidney this splits into a retrorenal layer, which joins the fascia anterior to the quadratus lumborum and vertebræ, and a prerenal layer passing between the kidney and peritoneum and joining the fascia over the great vessels in the mid-line. These have only fine connecting bands which run through the perirenal fat to the fibrous capsule. It is only fair to say that such a division into layers is rather hard to make out in the usual case which comes to operation. Through the fatty capsule the kidney is exposed and readily enucleated unless attached firmly as the result of inflammatory adhesions. If the fatty capsule is scanty, however, it may present almost the appearance of peritoneum or transversalis fascia. In this tissue are developed the perinophritic abscesses, and their spread and rupture may take several courses from close contact with the various anatomical structures present, although, strange to say, their rupture is rarely through the peritoneum.

THE OPERATIVE EXPOSURE OF THE KIDNEY

The free exposure of the kidney in any operative procedure will vary in degree according to the extent of the operation to be performed.

ABDOMINAL TRANSPERITONEAL METHOD

In the early days of kidney surgery, when operations were necessarily hurried, technic poorly developed, and diagnosis meagerly confirmed, as compared with the laboratory facilities of the present time, the abdominal transperitoneal method of reaching the kidney was frequently chosen as affording ready access to the renal vessels and expediting the completion of a difficult operation. The dangers of such an exposure render the procedure unjustifiable, except in a very few cases at the present time. The kidney is essentially a retroperitoneal organ—it is logical to remove it through the lumbar incision. The transperitoneal method increases the shock of the primary operation; increases the danger of lacerations of the renal vessels, vena cava, and even aorta, if firm adhesions to the posterior wall are met with; jeopardizes the circulation in the colon through incision or later pressure of blood clot on the mesocolon; lays the peritoneum open to infection by attacking an organ the lesions of which may be quite unsuspectedly septic, and makes any secondary operation much more dangerous.

The use of the method may be justified in (a) the removal of very large solid tumors of the kidney; (b) in those cases of trauma to the abdomen or lumbar region where intraperitoneal bleeding from the kidney is suspected, or where other hemorrhage from intra-abdominal viscera is probable; (c) in those few cases where a distinct mesonephron makes the kidney an essentially intra-abdominal organ.

LUMBAR ROUTE

Anatomical Considerations.- In exposing the kidney through the lumbar route, or through a combined lumbar and abdominal operation, the importance of the muscles and nerves of this region should be emphasized. Filling the groove at either side of the spinal furrow and extending outward about 2 in., we have the erector spinæ muscle, surrounded by the dense posterior and middle layers of the lumbar fascia. Lateral to this, and in the superficial layer of muscles of this region, are the latissimus dorsi and the external oblique, the former or more mesial fusing with the posterior layer of the lumbar fascia, its fibers running upward and outward toward the angle of the scapula. The fibers of the external oblique here are practically vertical. Beneath this superficial layer is the internal oblique with its partial origin from the lumbar fascia. The fibers of this muscle run upward and outward. The deepest, or third layer of muscles, overlying this region, shows laterally the transversalis and its aponeurosis fusing about 3 in. from the spines with the middle and anterior layers of the lumbar fascia, which here inclose the quadratus lumborum. The transversalis fibers here are directed practically horizontally, the fibers of the quadratus upward and slightly inward toward the mesial line. This latter muscle extends outward about a third of its width beyond the erector spinæ or about 1¼ in. laterally. Of these muscles, the outer border of the erector spinæ forms an easily felt landmark for lumbar incisions, while the outer border of the quadratus lumborum is a most valuable landmark, once the incision has been made.

Lying in front of the quadratus lumborum, but behind the anterior layer of its sheath, are the twelfth thoracic and iliohypogastric and ilio-inguinal nerves, important structures to spare in any incision in this region. These nerves pierce the transversalis close to the lateral margin of the quadratus, and the twelfth thoracic nerve runs obliquely downward and forward between the transversalis and internal oblique muscles to the rectus. The iliohypogastric and ilio-inguinal nerves maintain relatively the same direction as the twelfth thoracic at a slightly lower level, but pierce the internal oblique at a point just in front of the anterosuperior spine, and from here on lie between the internal and external oblique muscles. All are accompanied by vessels of small importance from the surgical standpoint.

In general, it may be said that no lumbar kidney incision should cut the dense fascial sheaths surrounding the erector spinæ, as suppuration here, if infection occurs, is apt to be prolonged and tedious. A nearly vertical incision through the outer segment of the quadratus lumborum must, of necessity, endanger the nerves lying on its anterior aspect, unless extreme care is taken. This is especially true if much room for exploration or manipulation is needed. The incisions of choice, then, for operations which involve a good exposure of the kidney are the obliquely vertical paralleling the course of the iliohypogastric nerve and just above it, or the slightly oblique transverse incision about 1 finger's breadth below the last rib and below and parallel to the twelfth thoracic nerve, which may cross the wound in its anterior extension, but can easily be retracted upward and saved.

With these considerations in mind, we may proceed to a brief description of the various incisions for exposure of the kidney by the lumbar route.

Preliminary Measures.—The patient may be placed in the prone, the lateral, or the semiprone position. In the prone position, a large pillow, air cushion, or sand-bag covered with a small pillow should be placed beneath the abdomen, in order to widen as much as possible the costo-iliac space and support or lift the kidneys into the field of operation. Such abdominal pressure is not to be recommended, and the lateral or semiprone position in which the patient lies with his sound side on the table, his under leg well flexed as to knee and thigh, and the upper leg less so, is much preferable. If now the adjustable kidney or gall-bladder platform underlies the sound side, between costal margin and ilium, the elevation of this platform will cause a marked lateral flexion and will correspondingly increase the costo-iliac space in which the incision is to be made. The same position may be easily attained by the use of 1 or 2 sand-bags. When suture of the wound is begun, these supports should naturally be removed.

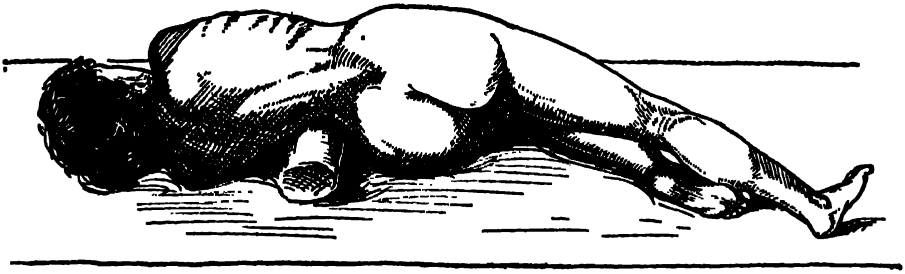


FIG. 4.—POSITION OF PATIENT.

The surgeon, in any lumbar incision, stands at the back of the patient, his first assistant opposite facing the patient and ready, if necessary, to aid in the delivery of the kidney into the wound by pressure of fingers or fist against the abdomen. We will presuppose on the part of the surgeon a knowledge of the functional activity of each kidney and a correct diagnosis as to the organ which is the site of the pathological lesion, although, even in these days of refined and advanced diagnosis by cystoscopy, X-ray, etc., an occasional case may be encountered where exploration of the healthy side may first be considered necessary. Even then, 2 lumbar incisions, one for exploration of the apparently sound side, and the second for the operative treatment of the diseased side, are much preferable to any transperitoneal method of reaching both kidneys through 1 incision, because, when such exploration is deemed advisable, the case, as a rule, presents a secondary bladder condition that has made cystoscopy difficult and uncertain—usually a tuberculous condition, where the diagnosis of the condition of 1 side is certain but the involvement of the opposite side is uncertain.

Variety of Incisions for Exposure of the Kidneys.—Probably no region of the body has been incised in more different directions than the lumbar region. In the development of the surgery of this region the kidney has been exposed by vertical incisions and transverse incisions, and triangular incisions varying obliquely between the 2, with bases both at the costal margin and iliac crest, by trap-door incisions and curved incisions with the convexity of the curve both forward and backward. Gradually, from this multitude of incisions, have been evolved the 3 or 4 which represent the types most in use at the present time, and among these the surgeon's choice must be determined by the nature of the operation undertaken and the conditions met with in the course of its execution.

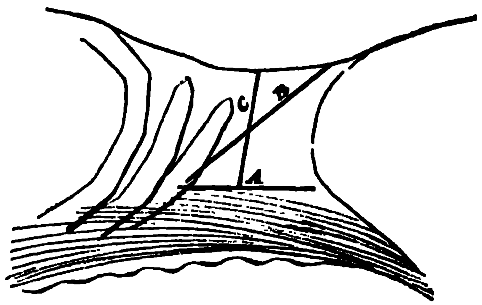


FIG. 5.—TRACINGS OF LUMBAR INCISION. A, Vertical (Simon); B, lumbar oblique (Bergmann and Israel); C, transverse (Johnson and Blake).

Three types, then, will be described in some detail and only mention made of some of the others:

(A.) Longitudinal (Simon) Incision.—This was one of the earliest incisions and still maintains a well-deserved popularity, especially in fixations of the kidney. The landmarks are the last rib, ascertained best by counting downward from above, and the outer border of the erector spinæ muscle. Just outside of the outer border of this muscle make a vertical incision extending from the last rib to a point just above the crest of the ilium. Section of the skin and superficial tissue is made without any hemorrhage of note. The superficial fascia overlying the superficial muscle plane is incised in the same direction as the skin cut, and the fibers of the latissimus dorsi exposed, thinner and more aponeurotic below, bellying out somewhat above. These fibers may be split, as they are only slightly oblique to the direction of the wound. Beneath is ex-

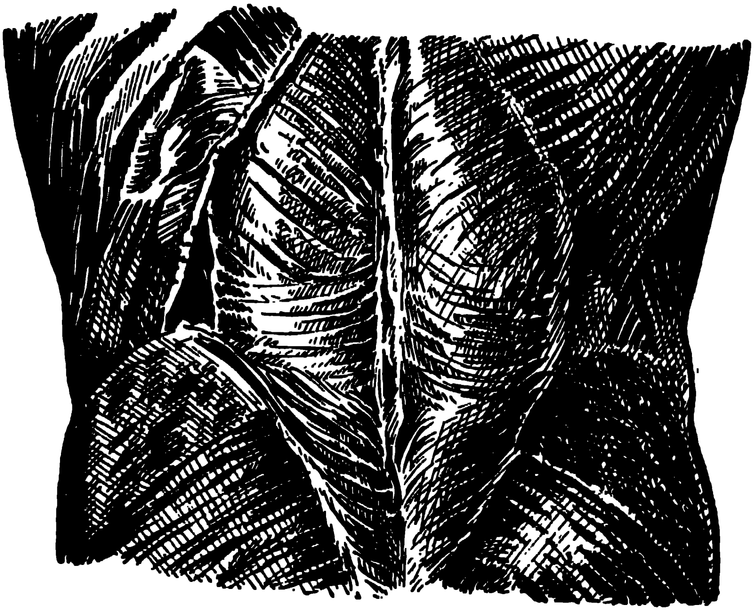


Fig. 6.

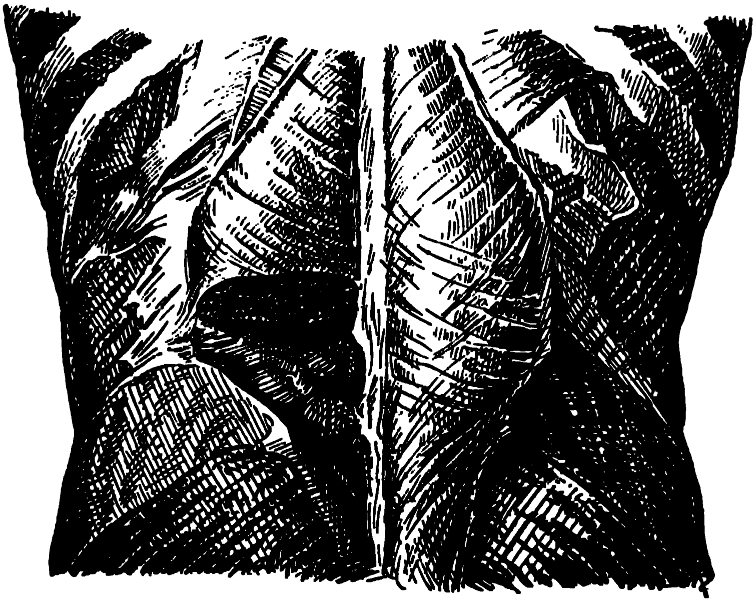


Fig. 7.

Figs. 6 and 7.—Muscles of Lumbar Region.

posed the sheath of the quadratus lumborum, if the incision has been kept well outside the erector spinæ. This sheath of the quadratus may be incised fully along the outer border of the muscle for its entire length, preferably beginning below and avoiding the region of the last rib until the finger may guide the dissection here; or the incision may be made in the sheath over the muscle and its fibers separated in a manner similar to the latissimus dorsi. In either case, the location of the twelfth thoracic and iliohypogastric and ilio-inguinal nerves, between the muscle and its anterior sheath and piercing the transversalis close to the outer border of the quadratus, should be remembered. These are retracted, if possible; connected by a simple neurorrhaphy if cut (Edebohls); and their inclusion in sutures carefully avoided as a possible cause of serious neuralgic pains later along their distribution.

The perirenal fat is now exposed by incision through the transversalis fascia or anterior layer of the fascia lumborum. The fat bulges into the wound, and may be easily torn through to expose the kidney. This may, if mobile, be delivered upon the back and further procedure determined, but this incision, as described, gives very little leeway for the more difficult operations. However, it may be enlarged in several ways: First, by a prolongation anteriorly at any level; second, by transverse division of some of the fibers of the quadratus lumborum; third, by prolongation upward with subperiosteal resection, or with simple fracture of the last rib. On account of these frequent necessities for enlargement of the wound and the possibility of dividing the nerves mentioned —in fact, the probability unless great care be exercised—I rather lean toward the incisions next described.

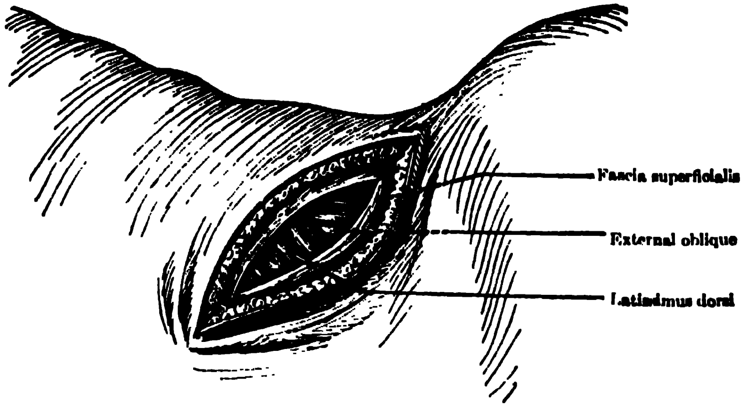


FIG. 8.—INCISION CARRIED THROUGH SKIN AND FASCIA EXPOSING MUSCULAR PLANE.

(B.) Lumbar Oblique Incision (Bergmann-Israel).—This incision is without doubt the most popular and most widely used of all the lumbar incisions. The landmarks are variously given by different authors, but the following description illustrates with slight variation the type followed in practically all:

From the outer edge of the erector spinæ, on a level with the twelfth rib, the incision is carried downward and forward to a point a finger's breadth above the highest point of the iliac crest. Here the incision may terminate or be prolonged further toward the junction of the outer and middle thirds of Poupart's ligament. The extent of the incision must be determined by the conditions met with. In general, exploration may be accomplished through an incision 4 to 4½ in. in length, and then the incision prolonged at its lower angle to meet the indications. While this length might do for a nephropexy, it would be found much too short for the removal of a large renal tumor or perhaps even for a kidney exploration in an obese individual, where not only the abundance of subcutaneous fat, but the excess of perirenal fat as well must play a large part in relatively decreasing the size of the wound. The incision is deepened through the first muscle plane, latissimus dorsi above and external oblique below, then through the second muscle plane of internal oblique. The aponeurosis of the transversalis and its muscle fibers toward the anterior end of the wound are then incised from a point slightly below the superior end of the wound. The extension of the wound at this end may more carefully be accomplished by inserting the finger beneath the aponeurosis and carrying the incision upward over the guiding finger, thus avoiding a blind incision which may injure the pleura. The iliohypogastric and ilio-inguinal nerves are held by the retractor with the posterior sectioned muscles, the twelfth intercostal with the anterior. The transversalis fascia is then incised and the perirenal fat

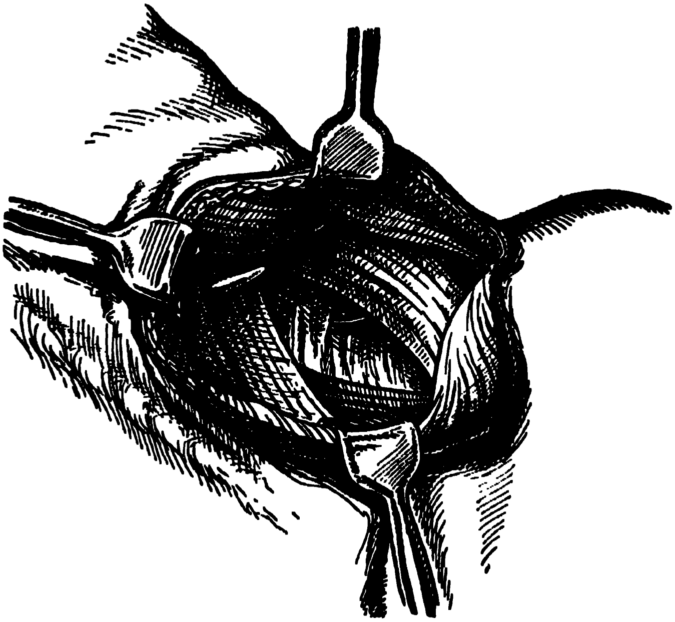


FIG. 9.—INCISION CARRIED THROUGH MUSCLE PLANE EXPOSING QUADRATUS LUMBORUM POSTERIORLY, INTERNAL OBLIQUE ANTERIORLY, THE APONEUROSIS OF THE TRANSVERSALIS BELOW.

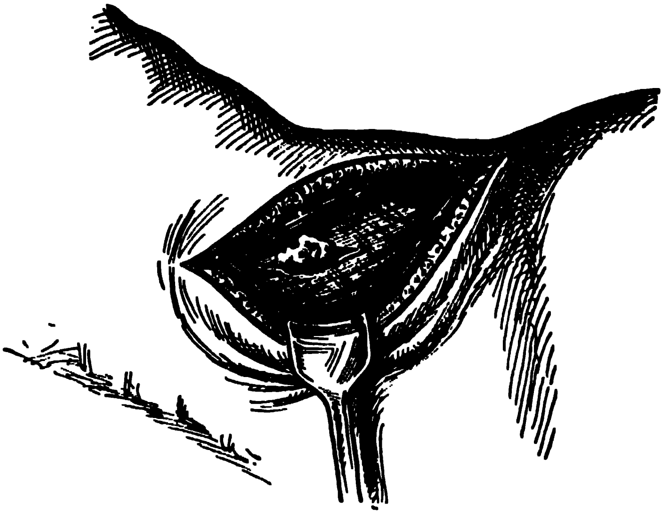


FIG. 10.—TRANSVERSALIS FASCIA INCISED AND THE PERIRENAL FAT LIES EXPOSED.

lies exposed in the wound. Always incise this last fascia first in the posterior part of the wound, then prolong the incision with a finger guiding it beneath. If this procedure is followed, no danger of opening the peritoneum will be met,

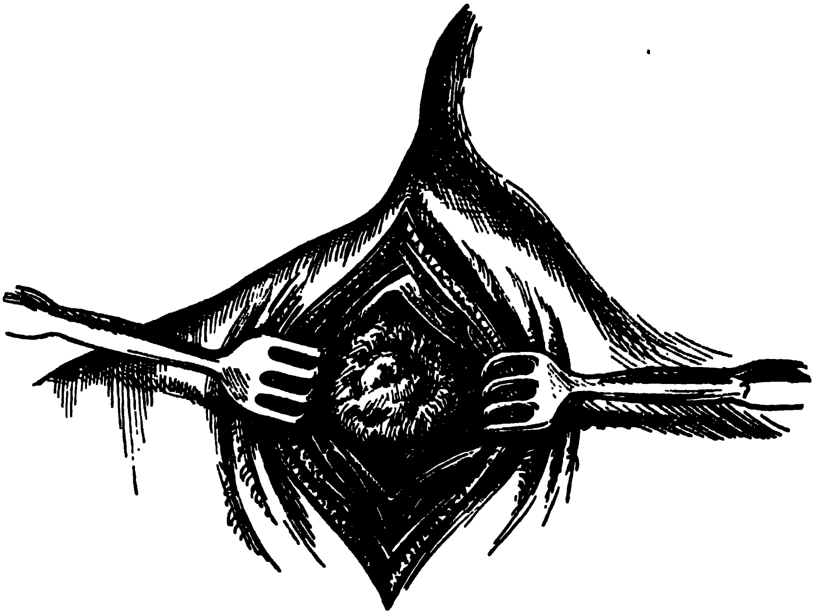


FIG. 11.—CAPSULE OF THE KIDNEY FULLY EXPOSED.

even in those cases where, through the agency of a remarkably mobile kidney, it may have come to lie far posteriorly.

The perirenal fat torn through, the kidney is exposed. Should this incision need enlarging, it may be done by prolonging the entire wound at the lower angle, as for following out the ureter, or at the upper angle, by extending it to the rib and possibly resecting this, by liberating it by incision through the costo-vertebral ligament, or by a liberating incision posteriorly through the fibers of the quadratus lumborum. In this connection, it might be said that, while injury to the pleura should always be guarded against, with every care as to technic, yet, when occurring in the course of the incision before infectious material from the kidney has escaped into the wound, no harm need result in any case. The lung remains in apparently normal state and shows no signs of collapse. The openings are naturally closed immediately, and apparently no harm results. Nor is the postoperative period attended by any untoward complications attributable to this cause.

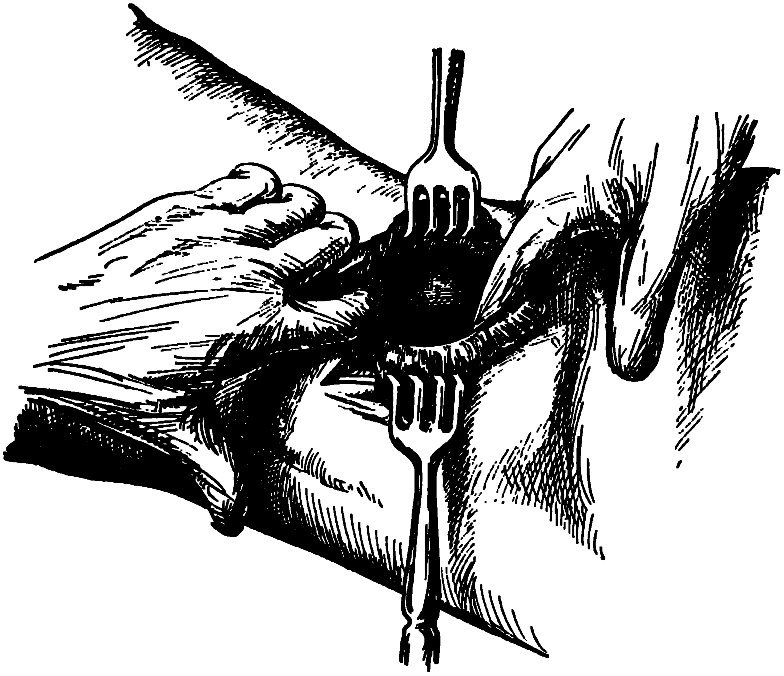


FIG. 12.—KIDNEY APPEARING IN THE WOUND.

In conjunction with the above incision, we wish to refer to the lumbar incision as described by W. J. Mayo (1) in January, 1912.

> "In 203 lumbar incisions, it was found necessary to cut the twelfth rib in 51 cases. In many cases, while exposing the posterior half of the twelfth rib for division, we observed that as soon as the muscular and fibrous attachments, especially the quadratus lumborum and the lateral arcuate ligament binding the twelfth rib to the transverse process of the first lumbar vertebra, were divided, the necessity for rib division disappeared. By putting a retractor under the angle of the twelfth rib, the upper margin of the wound including the rib was so mobilized that exposure of the kidney and pedicle was quickly accomplished."

Mayo's description of this incision follows:

"Beginning at a point 2 to 2½ inches lateral to the dorsal spine near the outer margin of the erector spinæ muscle, a longitudinal incision is made 2 to 3 inches in length through the skin, superficial fascia and posterior layer of the lumbodorsal fascia covering the erector spinæ. The incision lies behind the twelfth rib from the angle, if present, nearly to the head, and reaches downward to a point ½ inch below the angle. From this point, the incision passes obliquely downward and forward along the anterior margin of the quadratus lumborum muscle to a point an inch above the crest of the ilium and there, turning, runs forward parallel to the iliac crest as far as necessary. The posterosuperior lumbar triangle just beneath the twelfth rib is then exposed by cutting an opening through the external and internal oblique, transversalis and latissimus dorsi muscles, exposing the transversalis fascia in its lumbar portion. This fascia is then opened freely, exposing the perirenal fat. The iliohypogastric and ilio-inguinal are identified and retracted out of harm's way, and the lower part of the incision completed. The twelfth rib is then cleared in its posterior portion upward and backward, nearly to the articulation of the rib with the transverse process of the twelfth dorsal vertebra, and the pleura pushed upward. By retracting the erector spinæ on the one hand, and the costal margin on the other, a wide exposure is accomplished at the point of previous inaccessibility. Usually the kidney may be drawn through the wound with very little traction."

While this incision varies little in its lower part from parts of the König or Zuckerkandl's incisions, its mobilization of the twelfth rib is ingenious and markedly successful. Moreover, as Mayo says, the rib may, in addition, be fractured subperiosteally by a lateral twisting motion, should any further enlargement seem necessary.

(C.) Horizontal or Transverse Incision.- This incision may be compared to the posterior end of Pean's abdominal incision, or to the elevated supra-iliac arm of any of the triangular incisions. In the hands of Johnson and Blake of New York, we have seen it result so well that we think it well merits description. The incision is practically transverse, beginning at the anterior border of the erector spinæ at a point which will carry it a finger's breadth below the infracostal margin. This almost bisects the iliocostal space, falling a little above the mid-line, however, in the average case. The incision is prolonged forward to the point corresponding to the anterosuperior spine of the ilium. The incision is deepened in the same line through the latissimus dorsi and external oblique muscles and the internal oblique and transversalis are cut as their planes are reached. This results in practically a side-splitting exposure of the lumbar region, which may be enlarged anteriorly by carrying the incision downward toward the outer third of Poupart's ligament, or posteriorly by incising in the line of the incision thee lumbar fascia anterior and posterior to the quadratus lumborum and retracting this muscle backward. The twelfth intercostal nerve may be retracted with the muscles of the superior margin of the wound, the iliohypogastric and ilio-inguinal nerves with the inferior marginal muscles. With retraction of the last rib, excellent exposure of the kidney is accomplished and the necessary exploration of the kidney and ureter is easy. Moreover, this incision, while dividing transversely the outer planes of the muscles, divides the transversalis and layers of the lumbar fascia practically in the plane of their fibers and gives a strong healing wound.

Other Incisions.—Other incisions for reaching the kidney through the lumbar region include the triangular incision of König, the short arm vertical, the long arm above the iliac crest; the trap-door incision of Bardenheuer, with a vertical outside the erector spinæ muscle connecting 2 longer arms, a horizontal infracostal and a horizontal supra-iliac; and various T-shaped incisions, in some of which the stem goes forward, in some backward. None accomplishes more than can be effected through the above described incisions. These give wounds which afford good exposure, good drainage, and good postoperative union. All involve 3 muscle planes, and their sew-up should correspond to these 3 layers unless the condition of the patient demands a very rapid closure of the wound. Personally I like to close these wounds with interrupted sutures of chromic catgut for all the muscle layers, unless I expect considerable suppuration, when it is wise to eliminate as much chromic catgut as possible and substitute heavy plain gut for it, as the chromic gut tends to keep up suppuration until discharged. The skin and subcutaneous tissues may be closed with silkworm-gut alone, or with silkworm-gut and silk. Drainage and further details we will consider under specific operations.

NEPHRORRHAPHY: NEPHROPEXY

This operation of deliberately supplying artificial support to a movable kidney was first done by Hahn, in 1881, under the name of nephrorrhaphy. It was termed nephropexy by Le Dentu in 1889. Prior to Hahn's introduction of the operation, such kidneys as gave rise to marked symptoms had been removed.

Indications.—Without considering the pathology and diagnosis of movable kidney, the following types of cases may be considered suitable for operation:

1. Cases with a widely wandering painful kidney, who are otherwise well nourished and in good health.
2. Cases with signs of "intermittent hydronephrosis," or evidence of well marked dilatation of the renal pelvis as demonstrated by the ureteral catheter.
3. Cases with hematuria.
4. Cases with renal pain accompanied by vomiting relieved by the recumbent position.
5. Single, left-sided movable kidneys.
6. Cases in which the consciousness of the condition has given rise to a secondary neurasthenia.

Contra-indications.—Against these may be given the following contra-indications:

1. Cases of general splanchnoptosis, or with ptosis of stomach or liver.
2. Cases of primary neurasthenia, where the movable kidney is only an added focus for attention.

3. Cases where there are no symptoms.

4. When the pain is not relieved by the recumbent position. Perhaps no type of case better tests the judgment of the surgeon, as to when to operate and when not, than these. Certainly few types of cases have their statistics so adversely influenced as to ultimate results by the poor choice of cases for operation.

Aim of Operation.—No operative treatment for movable kidney is complete without a thorough exploration of both kidney and ureter, for it is in congenital defects of the latter or in anomalies about the vessels of the hilum that the surgeon frequently finds the etiological factor that determines renal mobility. The presence or absence of such factors determined, the kidney is artificially supported by any one of a number of methods, the choice depending largely on the taste of the individual surgeon. Probably no suspension of the kidney succeeds in fully re-establishing its normal anatomical position, but all should aim to accomplish this as nearly as possible in such a way that with healing of the wound, the resulting adhesions and scar tissue will maintain the new support. Various methods of renal suspension will now be described:

Technic.—The kidney is exposed through incision A or B. The fatty capsule is torn through, and, if too abundant, a part posteriorly excised so that it will not tend to push in between the kidney and the lumbar wound. Care must be taken here that the peritoneum remains unimpaired, as in a very mobile kidney it may so wrap itself about the organ as to make injury very easy. If opened, however, it is easily closed with a catgut ligature or running suture. The kidney is freed about its fibrous capsule, and the ureter and hilum explored for possible stone, abnormally low vessels, beginning hydronephrosis, kinks, etc. Gently the kidney is delivered into the wound, a procedure usually easy in this class of cases. The fibrous capsule of the organ is incised at a point over the convex border, and, on a grooved director or with blunt-pointed scissors, the incision is carried throughout the extent of the convex border. By blunt dissection with the handle of the scalpel or the finger, the capsule is then stripped back from either side, in 2 flaps, for a distance of 3/4 in. This will expose the parenchyma with little or no bleeding, usually, but if oozing occurs, it stops, as a rule, under the pressure of a gauze sponge. The exact position for the desired suspension of the kidney is then ascertained, and in this a position is sought as high as possible, but where tension on the suspending sutures will not be present. A 30-day chromic gut suture or a silk suture is then passed through the muscles and fascial layers of one side at the upper angle of the wound, then through the fibrous capsule of the kidney, doubled on itself, and carried across to and through the doubled fibrous capsule flap of the side, about 1/2 inch distant, and out through the muscles and fasciæ of this side. This is not tied, and the ends are left long for the present. Similar sutures are then passed in exactly the same manner along the fibrous capsular flaps to the number of 2 or 3 on each side, and left untied. Traction on the ends of these altogether will then bring the kidney into the wound, and its new position can be ascertained, as well as the security of the combined sutures, without too great tension. The deep parts of the wound in the back are then sutured together in 3 muscle layers, preferably with interrupted chromic gut sutures or chromic and plain alternating. The important kidney suspension sutures are then tied gently over the muscle layers without too great tension. The skin and subcutaneous fat are closed with silkworm-gut alone or with silk.

If much oozing has taken place or if drainage seems necessary, a small, soft rubber tube or a folded rubber dam drain is left in for from 24 to 48 hours, beyond which it is usually unnecessary. The patient is put to bed, with the foot of the bed slightly elevated, about 4 to 6 in., and a small soft pillow for comfort is placed beneath the scapula and buttock of the incised side. This will keep pressure from the wound; and the position, with the foot of the bed elevated, will tend to obviate any possible tension on the suspending sutures. This position is maintained with a little relaxation for about 3 weeks, following which the patient is slowly allowed up, giving fully 1 month to be up and about, with the further advice comparable to that of a hernia after operation.

During convalescence, the patient should be fed on a diet that will tend to increase the intra-abdominal and perirenal fat so that the support of these may be gained as an accessory to the operative suspension. With this kind of a convalescence, perhaps longer than many believe necessary, the wearing of post-operative supports is unessential. Such supports as exert pressure over the wound or on the kidney pouch are weakening rather than strengthening to the patient, as any wound or tissue heals better and more firmly under natural conditions of circulation than with pressure pads applied to it. Whether or not these patients should then follow out the orthopedic exercises that Hugh Cabot of Boston recommends for the elevation of the infracostal margin, and the increase in space in the upper abdominal and kidney segments of the abdomen, must be left for the future to decide.

The preceding operation is practically the technic described by Edebohls, except that his was usually through a muscle-splitting incision, and sutures through fibrous capsule were tied on either side. This operation, with minor changes in technic, is probably the one most followed in this country at the present time.

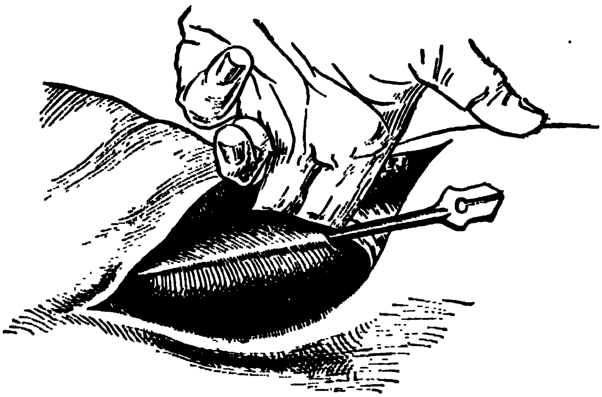


FIG. 13.—FIBROUS CAPSULE OF THE KIDNEY INCISED ON GROOVED DIRECTOR.

Albarran's Operation.—In this operation the kidney is exposed through incision B. The fatty capsule is torn through and the fibrous capsule exposed. The kidney is liberated and examined together with the ureter. Any abnormalities are noted and their indications met. Incision of the fibrous capsule on a grooved director along the convexity of the organ is then made, and the capsule freed completely from either side around to the hilum. The fibrous capsule on either side is then cut through the middle, making of it 4 flaps, an upper and lower on each side. The gathered end of each flap is then caught in a chromic gut ligature, the ends of which are left long. A full curved needle is then passed about the twelfth rib, hugging the bone itself, and an end of the long ligature on the upper anterior flap is carried about the rib. Similarly an end of the posterior flap ligature is carried about the same rib near the border of the erector spinae muscle. The surgeon then holds the kidney in its new position, while his assistant ties these ligatures. Should the twelfth rib be long, the ligatures about the rib are applied a short distance apart; if short, they may be applied at practically the same point; if very short, they may be passed about the eleventh rib or, as Albarran prefers, attached to the external periosteum of this rib and to the costovertebral ligament. This brings the kidney up under the ribs to about ⅓ its extent. The

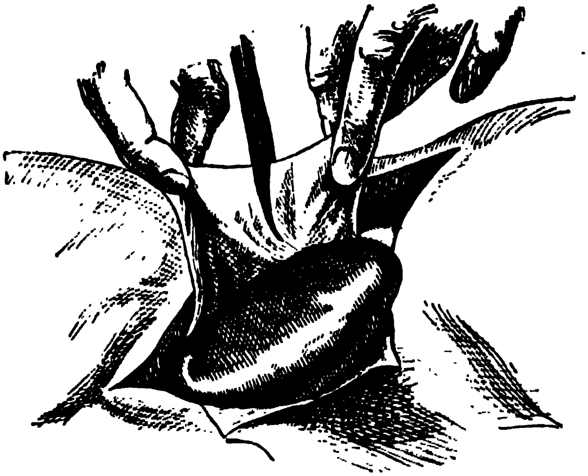


Fig. 14.—Fibrous Capsule of Kidney Which is Separated Completely from Either Side, is Cut Through Middle, Making Four Flaps, an Upper and Lower on Each Side.

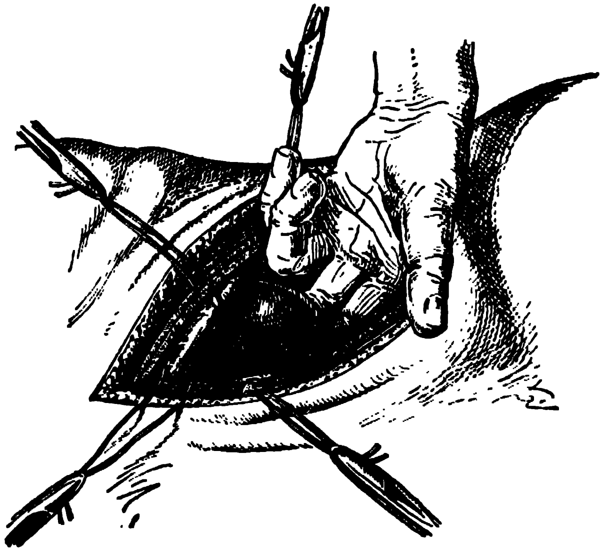


Fig. 15.—The Surgeon's Finger Holding the Kidney in Position While the Sutures are Tied.

position of the pelvis and ureter, for free exit of urine, is ascertained. Any fatty capsule which may possibly interpose between the kidney and the posterior abdominal wall is either pushed well below the kidney or excised. The ends of the ligatures about the lower capsular flap are then brought through the muscles of the corresponding sides and tied, and the wound is closed.

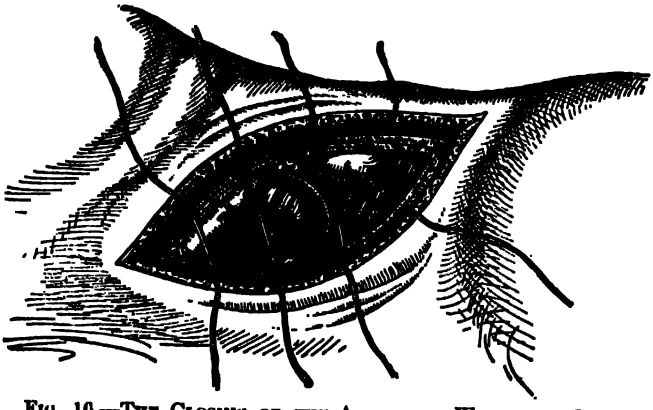


Fig. 16.—The Closing of the Abdominal Wall with Interrupted Sutures.

Suspension by Sutures Through Parenchyma (Kümmel, Guyon, etc.).—In the operation advocated by Kümmel, the kidney is exposed through a lumbar oblique incision and 3 silk sutures are passed through the capsule and parenchyma of the organ at its middle and upper and lower poles, taking in about 1¼ in. of the parenchyma to a depth of ⅜ in. along the convex border. These sutures pass through skin, muscles, and fasciæ of each side of the wound and are left long until the wound has been closed in layers; they are then tied across the surface of the skin incision. In the operation the fibrous capsule of the kidney is usually resected except at a point where the upper pole suture takes it in. In the hands of Kümmel, this method has proved very satisfactory. Guyon's procedure uses 3 doubled catgut ligatures through the decorticated parenchyma at practically the same points as Kümmel. These sutures are knotted at their entrance to and exit from the organ, and the ends left long. The upper suture is then passed about the last rib or through the costovertebral ligament after the method of Albarran, and the lower sutures through the muscles and deep fasciæ, making a suspension comparable to Albarran's, except for the fact that parenchyma is involved in the sutures. In tying any one of these sutures passing through parenchyma, the utmost gentleness must be used, as otherwise it will cut through the friable kidney substance.

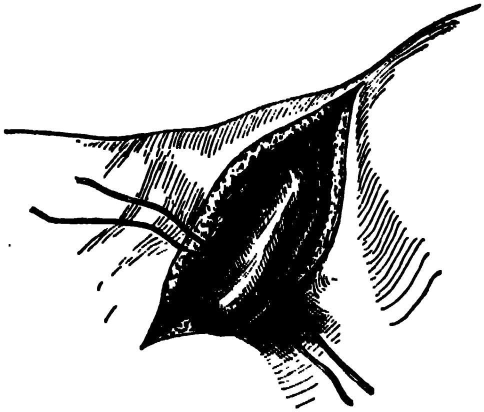


Fig. 17.—Sutures Passed through Fibrous Capsule and Parenchyma of the Kidney and Tied on Either Side.

While the above methods illustrate the main features of most kidney suspensions at the present time, various modifications of these methods are met with in the hands of various operators.

Israel's method takes sutures of doubled catgut through the parenchyma and then suspends the organ to the last rib subperiosteally by the outer of the 2 ends of the ligature through the upper pole. All other sutures are through the parietal wall and tied on the same side of the wound, none across the wound.

Jonnesco's method comprises an incision along the inferior margin of the twelfth rib, and the exposure of this rib along with the kidney. The fatty capsule is excised and the fibrous capsule split longitudinally and turned back on itself from the outer and inner doubled capsular flap. A curved needle is then passed through the skin 1 in. distant from the lower edge of the wound, through the muscles of the sacrolumbar mass, deep aponeurosis, folded inner flap of fibrous capsule, kidney parenchyma, outer flap of capsule, periosteum of external surface of rib, and the muscles and skin of the upper edge of the wound. One end of a silver wire suture is then drawn through, after which the other end of the suture is drawn through the same structures about ½ in. distant. The result is a ∩-shaped suture through all structures. Two such sutures are taken and each end of the loop on the skin has folded beneath it a small pad of gauze. The wound is closed and silver sutures left in ten days.

Methods of Vogel and Narath.—In the methods of Vogel and Narath, the twelfth rib is made use of as a direct support to the kidney by passing around the rib itself flaps of the fibrous capsule. With Vogel, these 2 equal flaps are cut longitudinally from the posterior aspect of the kidney and drawn upward behind the last rib, then outward and downward to be sutured again to the fibrous capsule, or they may be cut as 2 longitudinal flaps over the superior pole and anterior aspect of the organ, and turned backward on themselves to surround the last rib and be sutured to the fibrous capsule of the posterior surface. Narath incises the capsule along the line of normal relation of the twelfth rib to the capsule, and, by dissecting the upper and lower folds back for a short distance, brings the flaps together behind and over the rib, thus gaining a capsular flap support for the organ.

Choice of Procedure.—While these last methods are ingenious and interesting, most surgeons are thoroughly in favor of the simpler methods for kidney fixation. The results of a suspension by Edebohls' or Albarran's technic are as uniformly successful as any more elaborate or complicated method. Either one of these methods is in execution fairly simple. While many surgeons feel that fixation of the kidney to a rib entails a certain risk of poor union because of the continued movement of the ribs in respiration, cases of failure of the operation, as due to this cause, are hard to establish. Personally, I prefer a suspension to the posterior parietal muscles alone. Placing sutures through the parenchyma of the organ has always its attendant risks. The extent outward of the calices is never an anatomical certainty and should one of these project much more than usual, it is easily pierced by the retaining suture with the possible establishment of a urinary fistula. Not always is a suture purely through the parenchyma free from the same risk. Moreover, such sutures are always subject to slight strain, with accompanying cutting through of the friable kidney substance, and should no urinary fistula result, the attendant severing of blood-vessels, even of small caliber, and the consequent scarring of the organ, must be considered a disadvantage.

Additional Procedures. Edebohls found, he thought, a distinct association between right nephroptosis and chronic appendicitis due to the distortion of the cecum and ascending colon by the prolapsed kidney. Hence he advocated, *in such cases, lumbar appendectomy by opening the peritoneum and following the longitudinal bands of the colon to the appendix.* Along with this, exploration of the bile passages was also suggested. While the first of these additional operations is easily accomplished with the average appendix in a very few minutes, added to the length of the operation, its adoption must naturally be left to the individual indications met with and to the confidence of the operating surgeon in his own judgment. Certainly exploration of the biliary passages through the lumbar incision adds to the shock of the operation, as well as to the discomfort of convalescence, and should only be undertaken where specifically indicated, and only by the more experienced operators.

A much wiser addition to the operation, to my view, is that suggested by Harris, i. e., after completing the incision, retract the edges of the wound and observe carefully the ascending colon and the retroperitoneal cavity into which the kidney has been accustomed to glide. By a few well-placed sutures, obliterate this space by fastening the colon to the posterior wall (colopexy). The kidney is then suspended by any one of the various methods.

Results of Operation.—Newman stated that in his cases 75 per cent. were cured absolutely, 16 per cent. partially, 9 per cent. doubtfully benefited, and in 1½ per cent. the operation proved fatal. These results correspond closely, we believe, with the results of most operators who choose their cases carefully and conservatively. Even with a good technic, recurrences will be noted, as well as in a hernia operation. Otherwise the failures are very apt to represent a poor exploration for possible constrictions, kinks of the ureter, the fixation of the organ at such an angle as to establish a kink or lead to the poor emptying of the pelvis of the kidney, or the poor choice of the operative case.

DECORTICATION OF THE KIDNEY

Decortication of the kidney, an operation suggested and practiced by Edebohls for the relief of chronic or acute nephritis with high tension pulse, uremic symptoms, etc., practically describes itself as to the operative procedure. Incision and exposure of the kidney are as in nephropexy. Decapsulation of the kidney is completed with excision of the stripped-off capsule. The operation depends for its success upon relief of the intracapsular tension and the establishment of new vascular channels through adhesions between the decapsulated organ and the surrounding structures. It has had various advocates in different parts of the surgical world, but has never come into common practice and popularity.

Interesting in this regard, however, are the results of Martini's experiments on dogs in his study of the collateral circulation of the kidney. Following decortication, and after a period of months, the dogs were killed by bleeding. The renal artery and vein were ligated, and then colored gelatin was injected through the aorta and vena cava. Martini reached the following conclusions:

1. The new renal capsule is principally the result of growth of the interstitial connective tissue, and of the endothelium of the vessels of the cortical zone of the cortex.
2. The new capsule is firmly adherent to the kidney, is not of uniform thickness, but is thicker than the normal capsule. Its thickness is greater if the fatty capsule has been removed and nephropexy performed as well as decortication.
3. The new capsule shows no tendency to shrink or to sclerosis. It retains its normal structure and rich vascularity.
4. Decapsulation causes only temporary phenomena of hyperemia in the periphery of the kidney, and no epithelial degeneration.
5. There is a temporary decrease in the secretion of urine from simple causes.
6. Ligation of the renal artery or vein causes more degeneration and necrosis in normal than in previously decapsulated kidneys.
7. The collateral circulation through the new capsule can fully compensate for the stoppage of outflow through the renal vein when it is ligated; it only partly takes the place of the renal artery when that is ligated.
8. Decapsulation and simultaneous ligation of the corresponding renal vein are fatal.
9. If both kidneys have been decapsulated and are provided with a new formed capsule, one renal vein may be ligated and a month later the other also ligated, without death of the animal.
10. A dog can survive simultaneous ligation of the artery and vein of 1 kidney only, when the fibrous capsule of that kidney has been previously extirpated.
11. The collateral circulation of a previously decapsulated kidney is sufficient to preserve the life of a dog, when the other kidney is removed and the vein of the decapsulated kidney is ligated.

NEPHROLITHOTOMY

Nephrolithotomy, or the removal of a calculus through the substance of the kidney, was first performed by Morris in 1880. Practiced first as a conservative operation of choice, with certain indications given, it has gradually been replaced in a large number of cases by pyelolithotomy, which will be described later. Even with recent advances in the certainty of diagnosis of renal calculus by the use of the X-ray, ureteral catheterization, functional tests, etc., there are few operations where the technic is so often modified or absolutely changed by the local conditions met with on exposure and exploration as this one. Hence a contemplated nephrolithotomy will, in the judgment of the operator,

become practically any one of the other kidney operations and no surgeon should undertake it who is not equally confident of his ability to proceed to a most difficult nephrectomy.

Certain points in diagnosis are important helps in meeting indications: Whether the disease is unilateral or bilateral; whether primary or secondary to previous infection, and the bacteriological character of this infection if possible; the relative functional capacity of the 2 kidneys and their ascertained presence; and the condition of the ureters as to kinks, stones, or strictures. Most of these can be ascertained prior to operation; some, like the last, should be corroborated during the operation. With these considerations in mind and the general condition of the patient favorable, it is fair to assert that every stone in the kidney is an indication for early operation, excepting only those cases which pass "gravel" with absolute subsidence of symptoms and repeated negative X-ray examinations. The negative results of the latter in uric acid stones must not be overlooked.

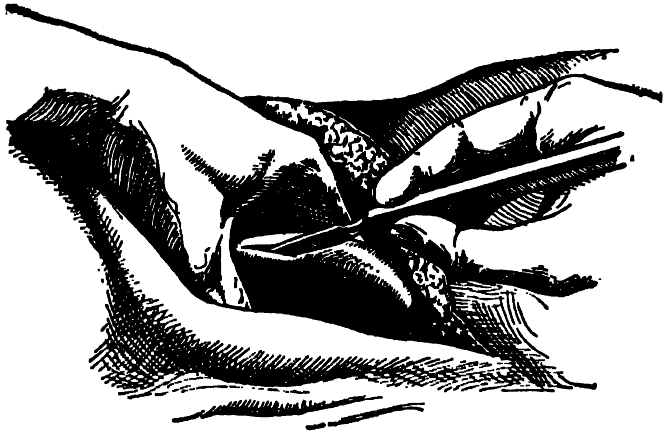


FIG. 18.—INCISING CORTEX OF KIDNEY; COMPRESSING PEDICLE WITH FINGER.

Technic of Operation.—The kidney is exposed, preferably by a lumbar oblique or transverse incision, and delivered on to the back so that its posterior surface is exposed to view and the entire organ may be easily palpated. A gross appearance may show any one of a variety of conditions—an apparently normal kidney, a perinephritic lipomatosis with small or atrophied kidney, a hydronephrosis, a small infected calculous abscess, or a large pyonephrosis. Each must give its own indication for procedure.

IN APPARENTLY NORMAL KIDNEYS.—In the first type, with the kidney delivered on the back, the pedicle is compressed by either the fingers of the assistant, by the rubber protected arms of an intestinal clamp, or by a constricting ligature of rubber tubing. Where feasible, if clamp or ligature is used, it is wise to catch the ureter separately, as this will facilitate the later exploration of both pelvis and ureter. This is, of course, unnecessary when digital compression is employed. With the kidney fixed between the fingers of the left hand, an incision is then made through the parenchyma along the line corresponding to the avascular zone of Hyrtl or Brödel (see p. 19), over which the fibrous capsule is somewhat thicker and more tenacious. This incision varies in extent from that recommended by Albarran, which is 1½ inches in length with its center at the junction of the middle and lower thirds of the organ, to a complete halving of the kidney substance. For exploration, the smaller incision is preferable and is carried directly through the parenchyma into the lower half of the pelvis. The finger is then introduced, and a complete tactile exploration of the calices of the lower half of the pelvis made. At this time compression of the ureter by the assistant or surgeon is made, so that no stones may slip into it, and any present are forced back into the pelvis. In making this incision into the lower division of the pelvis, it is always the endeavor to open first 1 of the calices, then insert the point of a grooved director, and incise this with the added information it gives as to pelvic topography; or to use 1 blade of the blunt-pointed scissors, and directed by this, continue the incision. Gerster recommends that such incisions be enlarged by opening the inserted closed blades of the scissors, holding that the danger of hemorrhage—especially secondary—from vessels torn across is less than from those sharply sectioned, the occluding thrombi in such vessels being firmer and less easily detached in the process of healing. The lower half of the pelvis having been explored with the finger, ex-

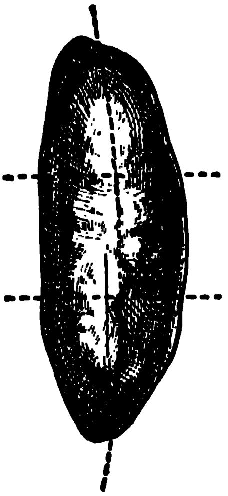


Fig. 19.—Showing Incision for Nephrotomy Just Posterior to the Lateral Cortex Border of the Kidney.

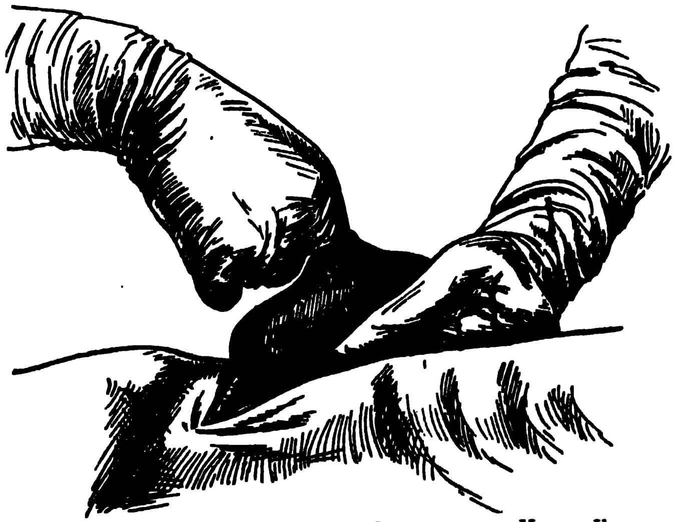


Fig. 20.—Finger Introduced Through an Incision in Parenchyma of Kidney Exploring the Pelvis.

ploration of the upper division of the pelvis is then made as methodically as was the lower. Usually it will be found that this may be done without enlarging the incision. At times, such extension of the incision upward is necessary and much preferable to rough manipulation with the end of the finger within the pelvis. The 2 halves of the kidney may then be thoroughly palpated between the internal finger and the external fingers. The stone having been found, its character influences further procedure. If small and lying in the pelvis, removal by stone forceps introduced along the guiding finger is easy; if large and free, the renal incision must be increased to accommodate its removal. If, however, the stone is large and irregular, with prolongations into the calices, lengthy incision of the parenchyma, to a point where freeing the stone under direction of the eye is possible, is much to be preferred to forcing it out through an incision too small, or to breaking the stone up into fragments, inasmuch as the first method may leave fragments within the calices or injure them in their rough removal of the stone, and any procedure fragmenting the stone leaves many possibilities for future calculi. Should the stone be imbedded in one of the calices, an effort may be made toward its removal by digital dilatation of the intrapelvic opening of the calix, followed by extrusion of the stone into the pelvis by pressure through the kidney parenchyma, and its removal through the original incision; or a new incision through the overlying parenchyma, directly onto the stone, may be made.

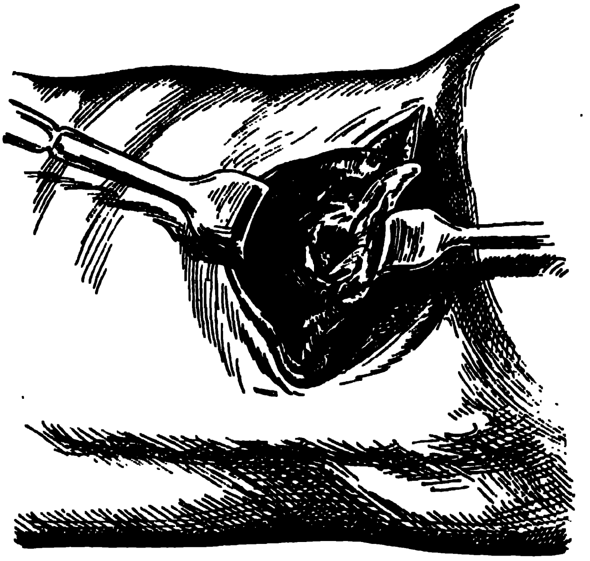


Fig. 21.—Entire Length of Parenchyma of Kidney Incised Exposing Stone in Pelvis.

Where a large phosphatic calculus has, on account of its softness, broken into numerous pieces, Albarran strongly recommends a thorough washing out of the pelvis and calices. With the assurance that all stones have been removed from the kidney, thorough exploration of the ureter should be made, and by palpating as far as possible, by noting any dilatation, and by passing a catheter downward into the bladder, evidence of the pressure or absence of any small calculus may be elicited. Even with the opportunity for the most thorough digital exploration of the kidney, pelvis, and ureter, the surgeon will always find that the presence of a good radiograph of these structures, taken within a

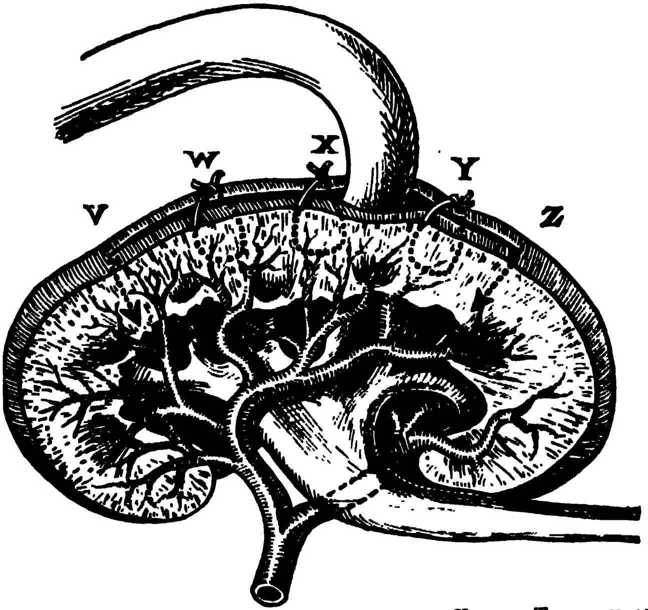


FIG. 22.—RUBBER DRAINAGE TUBE INSERTED INTO PELVIS OF KIDNEY THROUGH AN INCISION IN PARENCHYMA.

short time prior to the operation, will be a remarkable help in expediting the search for calculi. Having completed the exploration and removal of stones,

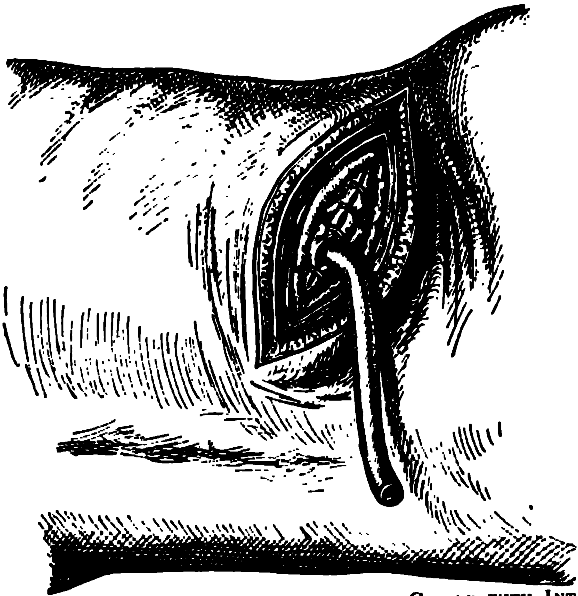


FIG. 23.—KIDNEY IN POSITION, INCISION IN PARENCHYMA CLOSED WITH INTERRUPTED SUTURES WITH RUBBER-DRAINAGE TUBE IN POSITION.

a small, soft rubber tube is then inserted into the most dependent part of the pelvis and the wound in the kidney carefully closed by plain gut sutures through the capsule and parenchyma, the tube coming through 1 angle of the wound. Such drainage will take care of any oozing into the pelvis that may follow the operation or any infection that may have been present and may be removed at the end of 3 or 4 days, if conditions are favorable. With this tube, a second drain to the outside of the kidney is hardly necessary, unless perirenal oozing is considerable or damage to the fat has been marked. The muscles and skin are then closed in layers and the operation completed.

IN CASES SHOWING PERINEPHRITIC LIPOMATOSIS.—In such cases as show a perinephritic lipomatosis, without much enlargement of the kidney itself, it may be advantageous to free the kidney by decortication of its capsule proper. The sutures for closing the wound in the parenchyma in such cases tear out very easily and require great care in their insertion. In all such sutures of the kidney, a round curved needle will be found much more advantageous than a cutting-edged needle, and sutures should penetrate almost the entire thickness of the parenchyma to gain good co-aptation of the sectioned surfaces. Should oozing still occur after closure of the wound in the kidney, the use of a small amount of gauze as packing will readily stop it.

IN INFECTED KIDNEYS.—Where the kidney is infected, showing either a small abscess about a stone or a pyonephrosis, drainage must be not only intrarenal, but extrarenal as well. The best material for this is soft rubber tubing, fenestrating only near the end the tube which drains the pelvis, and fenestrating in several places the tube to the perirenal tissues. When much perinephritis exists, or is anticipated, this perirenal tube may be doubled with only 1 arm fenestrated, and inclosing in this arm a small wick of gauze. This gauze is easily removed, and may be replaced by another small wick, and the double tube permits of irrigation into 1 arm and out the other. The length of time for drainage must naturally depend upon conditions as they progress, but where a calculus is removed from a clean case, the tube in the pelvis is seldom left for more than 3 days, and replaced by another small drain down to the perirenal tissues for a couple of days, when urine leakage will usually have ceased.

IN CASES PRESENTING HYDRONEPHROSIS.—If the kidney, at operation, presents a small or large hydronephrosis, this condition must be met and remedied. To drain by a lumbar tube the most dependent part of even a small hydronephrosis, will almost surely lead to a urinary fistula; hence, either by suspension of the organ or a plastic operation, the ureter must be brought into such position that it will drain the pelvis naturally. Frequently a ureteral catheter left in for a day or 2 will markedly hasten convalescence. When pus is present, or infection fairly well assured from the nature of the urine and of the calculus, it will be found of advantage to make the sew-up of the muscle layers of plain gut as far as possible, instead of using chromic gut; for the latter, in almost any pus sinus, will tend to keep up the discharge until it comes away, and in a kidney case every means should be adopted which will tend toward the early closing of the wound.

Experimental Findings.—In connection with nephrotomy, it is interesting to mention the experimental work of Isobe of the University of Kioto, Japan. He found in animal experimentation that the normal venous collaterals about the kidney are insufficient to sustain the life of that organ after tying the renal vein. After decapsulation and surrounding the kidney with omentum, the collateral circulation is better, but not good enough to avoid frequent necrosis of the center of the organ. However, with implantation of the omentum into a nephrotomized kidney, such an extensive collateral circulation was developed after 15 days that not only cortex but the central portions remained alive and well after ligation of the renal vein. Torikata of Kioto has tried it on the human subject with apparent success.

The details of a case treated by Mori, from the clinic of Nogano in Formosa, follow: A man, age 37, showing ascites secondary to a cirrhosis of malignant origin, underwent repeated tappings with only temporary relief. Laparotomy was done, the posterior parietal peritoneum was incised, the left kidney luxated forward, incised well into its central portion and the omentum sutured in. One month later the right kidney was similarly exposed, decapsulated, and the mesentery was sutured to the fibrous capsule. Four and one half months later ascites was still present. Ruotte's operation was done. Improvement followed. Nine months later, laparotomy was again performed to ascertain the condition, the ascites having disappeared. The saphena were found closed. Dense adhesions were present about the left kidney, and it was assumed that the collaterals in these accounted for the cure.

NEPHROSTOMY

Indications.—Nephrostomy, or the establishment of a true renal fistula; differs little in the manual operation from the nephrolithotomy previously described. While this operation still has its indications, they have become more limited as the technic of nephrectomy has improved and its mortality lessened. Alone or with decortication, nephrostomy is indicated in reflex anurias of calculous or of postoperative origin, as an adjunct to the medical treatment instituted; in certain hemorrhages of the kidney of traumatic or spontaneous origin; in certain congestive nephritic cases; in a limited number of hydronephrotic cases combined usually with a plastic operation to complete the cure; in some localized abscesses of the kidney, or, as practiced by some surgeons, in certain pyonephrotic conditions. In the pyonephrotic cases, the operation is being more and more limited to such cases as are seen so late that nephrectomy seems contra-indicated on account of the general condition of the patient, or to such cases as show a functional incapacity or absence of the other kidney.

Technic in Cases of Calculous Anuria.—In nephrostomy for calculous anuria, as described by Albarran, who considers the condition practically entirely of reflex origin, the technic is almost identical with that of nephrostomy and nephrolithotomy. The kidney and pelvis having been incised, effort is quickly made to locate the stone and remove it. This may be easily and rapidly done if the stone be found in the kidney, pelvis or upper part of the ureter, but if quick search reveals no stone in these positions and retrograde catheterization of the ureter shows the stone low down in the ureter, it is usually wise to postpone its removal until renal function has become re-established. It must not be forgotten that this is the primary object of the operation, and undue manipulation and handling of the kidney may defeat this object; whereas, with incision and drainage, the kidney is prone to resume its function and later operation may remove the cause of the anuria. In all such cases, it is wise to drain the pelvis of the kidney with a soft rubber tube. If the surgeon has been able to remove the cause of the cessation of function and ureteral permeability is normal, this drain may be removed at the end of 3 or 4 days; if, however, the cause has not been removed, it may be wise to leave the tube until the secondary operation has been performed, as its removal too early in such cases has been followed by a recurrence of the anuria. In the cases of intrarenal hemorrhage, either from trauma, angioma, or erosion of a small vessel by a calculus, operative procedure is practically the same if nephrostomy seems indicated. Here, however, it may be necessary, after stopping hemorrhage and removing the clots, to resort to the use of some gauze packing to make sure of no recurrence of bleeding. All clots must be thoroughly removed and given no opportunity to re-form: otherwise occlusion of the ureter from a small piece of one may result, and a renal fistula more or less permanent may be formed. When necessary to use gauze (and usually this may be obviated by pressure, hot salines, etc.) this may be carried to the bleeding point through a soft rubber tube or rolled in rubber dam, either of which will keep it from sticking tenaciously to the cut surface of the renal tissue. In the operation, as suggested for those large congested kidneys with heavy albuminuria, decortication usually accompanies the nephrostomy. In nephrostomy for hydronephrosis, the operation is practically always secondary to the plastic operation which will result in the cure of the hydronephrosis. These we will leave for later discussion.

Technic in Pyonephrosis.—Pyonephrosis gives to most surgeons at the present time their major indication for nephrostomy, but this indication is influenced by many considerations beyond the pure favor of the surgeon for this operation. While most of these cases are the result of an infected hydronephrosis—which in turn came from calculus, ureteral kinking, stricture, or abnormal relations and implantation—once the condition is established, operative procedure must depend upon the general condition of the patient, the functional capacity of his kidneys, the difficulties met with at operation, and the skill of the surgeon operating. Advocated by some as a conservative operation, it has been followed so frequently by a permanent fistula, necessitating a difficult secondary operation, perhaps nephrectomy, that it has gradually become healthily limited in its employment; this, largely through the improvement in diagnosis, gained by the cystoscope and the improvement in the technic and results of nephrectomy. At the same time cystoscopy and ureteral catheterization have markedly aided the technic as practiced by Albarran, who has published some striking results of conservative operations upon pyonephrotic cases without the formation of a long lasting lumbar fistula. The technic of the operation, as described by Albarran, follows:

Prior to operation, whether during diagnostic procedure or not, the ureters are catheterized through the cystoscope, and in the ureter of the affected side the catheter is pushed well up into the pelvis of the kidney, if possible. This catheter is left *in situ* as an aid not only to locating the ureter at the time of operation, but especially to locate the ureteral orifice in the pelvis of the kidney, frequently an extremely difficult thing to do at the time of operation.

Incision is then made down upon the perirenal fat in the usual manner. This incision need not be very long until the exact conditions are discovered, when, if necessary, further prolongation may be made. The perirenal fat is then incised down to the convex border of the kidney, or, if thinned out over the tumor mass, incision is made here. The perirenal fatty capsule, markedly thickened and adherent, as a rule, in this type of case, is not separated to any great extent from the surface of the kidney, as this leads frequently to much sloughing of the friable fat and the formation of annoying pockets of pus, with the drainage to be used later. With the finger, the operator then ascertains by palpation the point for incision into the kidney, a point where parenchyma seems most thinned out and where the elastic feel of a pus pocket is easily apparent. If adhesions are few and do not wall off the wound, this is packed about with compresses to take up the pus. Should the pyonephrosis be large, part of the fluid may be removed through an aspirating trocar or by a syringe. In any case, incision is then made into the pyonephrosis to admit the finger, and then sufficiently lengthened for exploration with the finger as a guide.

Digital exploration of the entire pus cavity is then made. If unilocular, this is easily accomplished; if multilocular, all the various compartments must be opened so that drainage into the pelvis may be easy and complete. When all this is accomplished, it is best to make sure by bimanual palpation of the entire kidney, one finger within the kidney and the other hand outside or on the abdominal wall, if necessary. At this time any pyogenic membrane lining the cavities should be removed either by the finger or by gauze, and the cavity be gently irrigated out with water or a weak silver nitrate solution. Frequently in breaking through the various compartments of a multilocular pyonephrosis of old standing, vessels will be found in the separating partitions of such size that ligature will be advisable. Where this is necessary, the renal incision should be prolonged to a length sufficient to enable the surgeon to do this under his own eye, as otherwise annoying hemorrhage may result.

The cavity having been cleansed, the mouth of the ureter is recognized by the ureteral catheter or sound introduced prior to the operation. If such introduction has been incomplete, owing to kinks, curves, stone, or other cause, an attempt is made to recognize the mouth of the ureter by feeling with the finger for the small depression at its site. With the mechanical obstructions removed by the operation thus far, it may be easy to push the ureteral catheter through into the pelvis. Over the point of this may then be placed a No. 12 or No. 13 catheter or tube, fastened to the inner catheter either by its close fit or by a fine silk suture and vaselined at the point of junction; more by gentle manipulation from above with the lower catheter as a guide, than by pulling from below, this larger drainage catheter is introduced from above downward. It is fenestrated in 3 or 4 places in the last inch and a quarter at its upper end, and this is left projecting into the pelvis of the kidney for drainage. Through the last eye may be passed a suture, which is brought out through the skin to maintain the position of the catheter for the first few days.

At this time, it is well to obtain the relations of the ureteral orifice and the depth of the pyonephritic cavity. When the latter is small and the kidney mobile, it may be that fixation of the latter in proper position will afford the pocket complete drainage through the ureteral catheter. This is the consummation of the brightest hopes, but is unfortunately uncommon. More often, the pus cavity is so large and the perirenal adhesions so dense, that such a course is out of the question and exploration is more for the purpose of ascertaining exactly what must be done in a later plastic operation for the cure of the condition. Suffice it to say that in the presence of the pus of a pyonephrosis, any extensive plastic surgery should not be attempted, as it is almost certain to fail, and such failure in any extensive plastic repair frequently precludes the possibility of really good repair at a secondary operation.

Having gained this information as to the extent of the pocketing and its relation to the ureteral orifice, the lumbar drains are introduced into the cavity—1 soft rubber tube, if small, 2 if large and extensive. Any pockets about the kidney are similarly drained, and the parietal muscle layers are brought together with sutures of heavy plain gut with occasional chromic sutures down to the site of the tubes. It is now wise to ascertain the efficacy of the drainage of both the ureteral and lumbar drains by injecting fluid first into the ureteral catheter and forcing it out through the lumbar drains; then through the latter, and forcing it out through the ureteral drain. With drainage successfully completed, the skin wound is closed down to the site of drainage by sutures of silk or silkworm-gut.

During the first few days following the operation, the kidney is lavaged twice daily with sterile water, followed by boric acid solution or silver nitrate solution. This lavage takes place through both the ureteral and lumbar tubes. When the pocket has cleared largely of its pus and detritus, as shown by the washing—and this may be in from 4 to 10 days—the lumbar drains are removed. The ureteral catheter will then usually suffice for drainage, and the lumbar sink quickly close. Lavage is continued after the same manner through the ureteral catheter, and this is not changed until permanently withdrawn, unless it becomes encrusted with urinary salts. If this happens, a small obturator may be passed to the pelvis, within the catheter, and this withdrawn. A clean catheter may then be introduced over the obturator and the latter withdrawn. In plugging the catheter, the same obturator may be used.

With the clearing of the urine in from 3 to 5 weeks, the ureteral catheter is withdrawn, and by this time the lumbar wound is usually healed. With the use of a ureteral catheter in this way, the lumbar sinus usually closes within a week after the removal of the drains; in fact, very little urine escapes this way after the drains are out, if the patient is kept in the proper position for good ureteral drainage. Prior to removal of the lumbar drains, most of the urine comes this way, and the use of a connecting tube and bottle or rubber urinal is advisable. When introduction of a ureteral catheter has been impossible, the lumbar drainage is best continued for months, or as long as necessary, for once it is removed, the cicatrization and consequent narrowing of the sinus walls may lead to a recurrence of the original symptoms.

The above description of nephrostomy as done by Albarran constitutes a most surgical procedure, which takes advantage of every opportunity offered to save the kidney. Its extreme conservatism, as against nephrectomy, must appeal alike to surgeon and patient, even where the unaffected kidney maintains a normal function. The failure of the operation, however, may involve a secondary nephrectomy, the mortality of which, at the present time, considerably exceeds that of primary nephrectomy. However, such nephrostomy may tide the patient over a critical period, when nephrectomy would be inadvisable on account of his general condition. The operation may be modified to meet any local condition present. Its technic illustrates well the principles to be followed in any modification which may be practiced.

NEPHRECTOMY

Indications.—The kidney is removed for injuries; for infections, such as tuberculosis and pyonephrosis; for multiple calculi, especially with added infections; for cysts, whether simple or hydatid, and occasionally for polycystic conditions; for persistent ureteral fistulæ; and for new growths, whether hypernephroma, carcinoma, or sarcoma. Nephrectomy, in any one of these conditions, may be very simple or extremely difficult, according to the size of the kidney, the extent of its involvement in the process which indicates the operation, and the extent of infiltration or involvement of the perirenal tissues in the inflammatory or neoplastic process which bespeaks removal of the organ.

Choice of Procedure.—Nephrectomy, according to the time done, may be either primary or secondary; according to the extent and manner of removal, either complete or partial, extracapsular or subcapsular; and according to the route chosen, either lumbar, abdominal, or combined. As to time, primary nephrectomy is the operation of choice. Its mortality, in various statistics, is about ½ to ⅔ that of the later operation; and with the improvement in the diagnosis of the condition present, the facilities for ascertaining the functional capacity of the opposite kidney and the improved technic of operation, the mortality of the operation itself is only about ¼ what it was 15 years ago. While it may seem the part of conservatism to leave in a kidney which is the seat of many calculi or of moderate pyonephrosis, the tendency is more and more toward an attitude which judges real conservatism by mortality, and removes an organ the seat of less advanced disease rather than wait for the possibilities of persisting fistulæ, chronic suppuration, or recurrence of previous conditions which make the secondary operation imperative. In no place can the judgment of the surgeon be better exercised than in choosing his course when he cuts down on a kidney which presents this question of removal or simple drainage.

As to partial nephrectomy, this operation is largely obsolete, except in cases of injury or disease where the integrity of the second kidney is such that it gives an absolute contra-indication to the complete removal of the first. Where such partial removal is indicated, the injured or diseased portion is cut away in the form of a wedge, while the assistant controls the pedicle. Then, healthy tissue having been attained, the raw surfaces are brought into apposition and held there by interrupted sutures of plain gut through capsule and parenchyma. Where this is easily possible, union may be quick and satisfactory. Where the amount of tissue removed has been fairly extensive, and apposition of cut surfaces is impossible, these must be left to heal by granulation with a certain amount of gauze packing to control hemorrhage the first few days. If the pelvis or a calyx of the kidney has been incised, urinary drainage will occur for a few days and may delay the postoperative recovery. The operation is then limited in scope and application and must be very definitely indicated for its choice by a surgeon. Similarly, whether nephrectomy shall be extracapsular or subcapsular, must be left to the conditions found at the time of operation. As to the route chosen for the operation, except in cases of large solid tumors of the kidney or in cases of an affected, movable, intra-abdominal kidney, the lumbar incision is much to be preferred. Primary lumbar extracapsular complete nephrectomy is then the operation of choice, whenever applicable, and will be described first.

Technic of Primary Lumbar Extracapsular Complete Nephrectomy.—The choice of the lumbar incision will depend upon the surgeon. Preference should be given to either the transverse or oblique, prolonging either of which will give plenty of room without angulation of the wound. A liberal incision is absolutely essential to facility in operating. The incision is deepened to and through the muscles in layers, as described under incisions. The fatty perirenal tissue, coming into view, is then separated either by incision or by the fingers, so as to expose the kidney. Beginning with the posterior surface exposed to view, the fatty capsule is then stripped off the fibrous capsule with the fingers. These are passed both in front of and behind the organ, about its upper pole and about the lower pole. When little perirenal inflammation is present, this stripping of the fatty from the fibrous capsule is readily accomplished, and keeping close to the latter, the peritoneum and gut are pushed forward easily. When, however, as the result of long inflammation, the fatty capsule is firmly and densely adherent to the fibrous capsule, the utmost care must be exercised in the enucleation of the organ. It is here that a liberal incision will show its advantage and will make easier a difficult task. With scissors or scalpel, keeping close to the fibrous capsule, the kidney is gradually freed by sharp dissection, care being taken to avoid the colon and peritoneum, and, if necessary, leaving a bit of the fibrous capsule, if too adherent to these structures. It is in these cases, when done secondarily as subsequent to a nephrostomy, that these adhesions become so dense, almost leather-tough in consistency, that enucleation is practically impossible and a subcapsular separation of the kidney becomes necessary.

Having enucleated the kidney both above and below, the ureter is either seen or felt below, lying on the psoas and covered closely with peritoneum. This is isolated as far down as possible, and is clamped off. A chromic gut ligature is then passed about the ureter both above and below the expected line of section, and the ureter cut through with the cautery. The severed ends, suspended by the ligatures which have been left long, are then cauterized within the lumen and made as clean as possible. Should the ureter be dilated, care should be taken, before sectioning it, that all urine and detritus are squeezed back behind the ligatures; otherwise soiling of the wound may occur when the ureter is sectioned with the cautery.

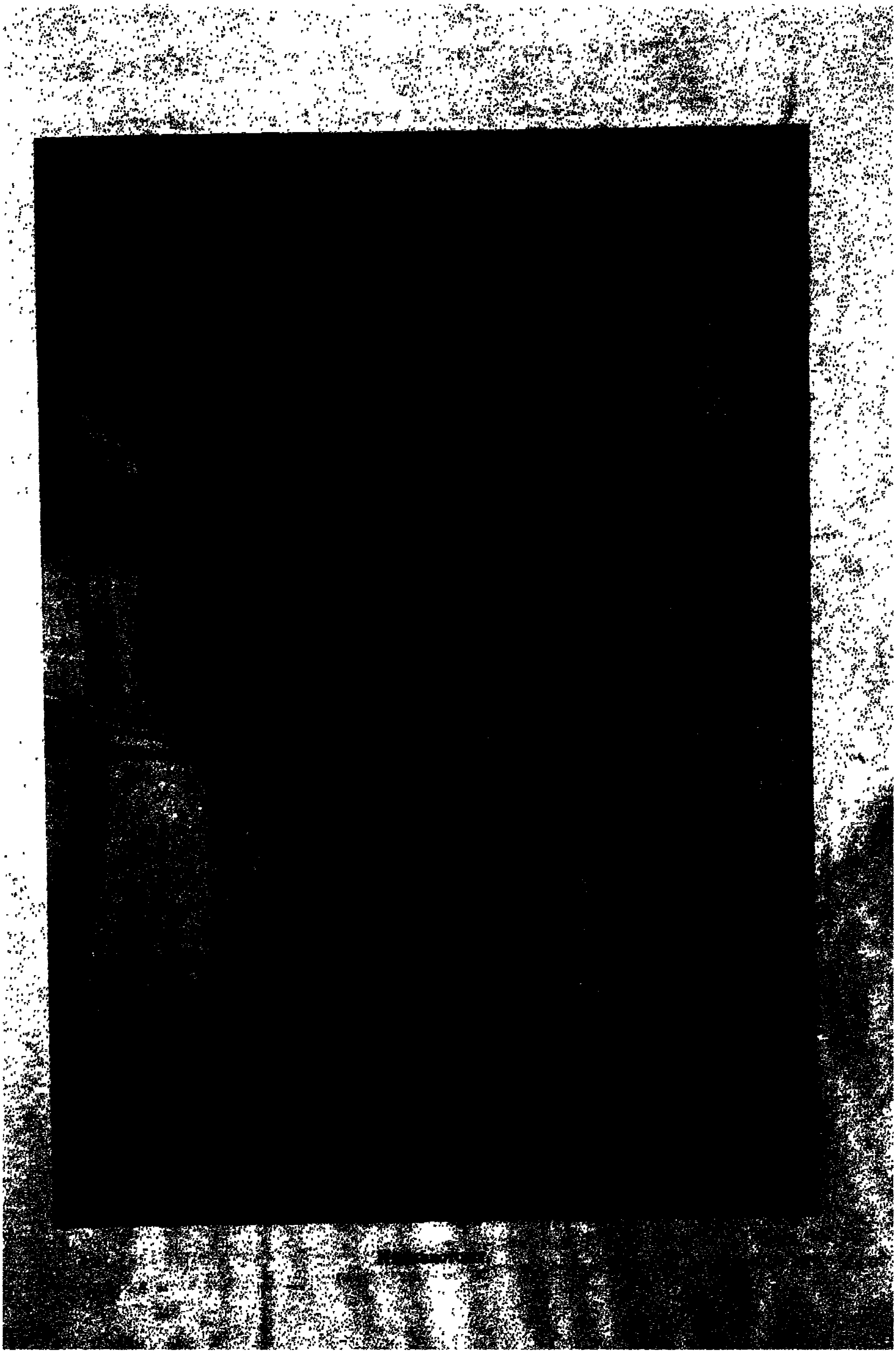
With the ureter freed, the kidney may, as a rule, be delivered on to the back, if this has been impossible before. The pelvis of the kidney is now freed from its fatty covering as far back as possible on the pedicle. This will avoid catching any part of fat in the ligatures applied to the pedicle, and so running the risk of slipping of the ligatures. The manner of applying the ligature to the pedicle will then vary with the choice of the operator. If, after section of the ureter, the kidney may be delivered well into the wound or on the back, ligating the pedicle is much facilitated by having everything in plain view. The pedicle may be seized with a large clamp close to the pelvis and well down on the pedicle, a No. IV plain gut ligature may be applied, including the vessels en masse, or, better, with the finger forceps, or a Cleveland carrier, this ligature may be so carried double through the structures of the pedicle that each half of the pedicle may be included in a separate ligature. The kidney may then be removed, leaving the clamp and ligature on the stump. Removal of the clamp will now enable the surgeon to review the vessels of the stump and ligate any individually which may tend to ooze. To make doubly sure, it is well to slip another ligature of finer chromic gut down over the first one about the pedicle, and there tie it.

In the above procedure, where one has the kidney in full view, the steps are easy and the clamp is really unnecessary. Where, however, the pedicle is short and thick, containing a mass of fibrous and fatty material, making it dangerous, if not impossible, to bring the kidney well into the wound even with fracture or resection of the lower ribs, the ligation of the pedicle is a much more difficult task. With the kidney fully isolated and the pedicle freed as much as possible, by finger dissection, even then practically nothing can be done in plain view. The pedicle must be seized between the index and middle fingers of the left hand, and with these as directors, the jaws of a fairly heavy curved or right-angled clamp are made to pass about the pedicle and closed a short distance from the pelvis. If the kidney is small enough so as not to completely fill the field of operation, a plain or chromic gut ligature may be passed about the pedicle behind the clamp and tied. The kidney may then be cut away and further ligatures applied under direction of the eye. Occasionally, however, it is advisable, and practically necessary, to cut away the kidney, trusting to the clamp alone for hemostasis, and then, with the increased room given, to apply the ligatures to the short, thick stump of the pedicle. With the care of the pedicle completed, the wound is sponged out, any aberrant renal vessels which may not have been included in the ligation of the pedicle are cared for, and drainage inserted—usually a small, soft rubber tube to the stump of the ureter, and a slightly larger tube to the renal pouch. The wound is then closed in layers, as described heretofore, 3 muscle layers and the skin.

If the operation has been fairly clean, but the space left after removal of the kidney fairly large, a few plain gut sutures through the fatty capsule may help to obliterate this space and hasten recovery. Ordinarily this perirenal fat will fall together sufficiently, especially when the renal prop on the table is let down or removed, for the sew-up of the wound. Where the kidney has been removed for tuberculosis, Mayo suggests the use of no drainage, but fills the cavity with from a pint to a quart of saline. This he believes obviates the tendency toward a tuberculous sinus, as the saline furnishes a poor medium for any attenuated tubercle to take on renewed activity. He also treats the ureter by injecting into it about a dram of liquid carbolic acid, a proceeding he finds effective and harmless.

The above nephrectomy, while typical for most non-malignant cases, will vary in details for different cases. In those cases where a tuberculous ureter accompanies a kidney similarly affected, ureterectomy to a point as low as possible must be performed. The stump of the ureter may be grasped in the wound above by a long clamp or sponge forceps and this be pushed down retroperitoneally toward the iliac fossa. Here, an intermuscular incision may be made and the ureter recovered extraperitoneally, when it may be excised to a very low point in the pelvis or be sutured into the wound. When excision is done only from above, through the lumbar wound, the treatment of the stump of the ureter varies almost as much as that of the appendix. If it is clean, it may be ligated and simply dropped back into the wound. If it is infected and dilated with pus and detritus, the contents should be thoroughly removed, the lumen washed or curetted lightly, and the stump cauterized with either carbolic acid or the actual cautery, when it may be ligated and allowed to retract into the wound; or the stump may be left open and sutured lightly into the lumbar wound. In any case where the stump is allowed to retract into the wound it is better to deprive it of its mucous lining near the distal end, either by cautery, carbolic acid, or curetting, and to invert it lightly to close the opening.

Where nephrectomy is done for hydronephrosis of large size, especial care must be taken in the recognition of the fibrous capsule of the kidney. Having exposed the fatty capsule over the hydronephrosis, this fat should be incised carefully layer by layer, as it is held up by an assistant with forceps. Frequently many firm layers will thus be incised before reaching the capsula propria. This having been reached and identified, it is carefully cleaned over as large an area as possible without breaking the wall. A trocar and cannula, provided with a good length of rubber tubing, are then inserted and the contained fluid allowed to flow away. The point of puncture with the trocar is caught with finger or forceps as the trocar is withdrawn, and the now flaccid hydronephrotic sac is brought gradually into the wound. As this is slowly delivered into the wound with the left hand, the flat of the fingers of the right hand carefully separates the adhesions from off the surface of the sac. Where these are tough and firm, they must be ligated and divided. The tips of the fingers are little used, as they frequently puncture the sac wall. Slowly the entire sac is separated around to the hilum of the organ and delivered into the sac. As the hilum of the kidney is reached, it is frequently found that the veins spread out in wide range over the adjacent sac wall. In good view as they



are, if the procedure has been undertaken as described, they may be ligated individually and cut. The pedicle then easily comes into view if it has been obscured previously, and may be ligated, the kidney removed and the operation completed.

Lumbar extracapsular nephrectomy, as described above, must necessarily have other modifications to meet the pathologic findings. While the description above will meet the average case, other suggestions and the rationale of their procedure are far from out of place. When, on incision, the perirenal fat is first met with, the condition of this fat may be a direct aid in the diagnosis or confirmation of the diagnosis of the condition present in the kidney. Gerster well summarizes these changes in his study on nephrectomy. In acute or stormy infectious processes, as in acute septic infarcts, in acute septic parenchymatous or gonorrheal nephritis, in short, whenever a marked acute swelling of the parenchyma produces great tension of the fibrous capsule, the perirenal fat is invariably found in a state of acute edema. In chronic processes, on the other hand, as in calculous disease or tuberculosis of old standing, this fat may have largely or practically entirely disappeared. Nothing may remain but a fine network of thin connective tissue, in which case extracapsular nephrectomy may be easily effected; or the fat may be replaced or condensed into extremely tough and resistant adhesions between the fibrous capsule peritoneum, diaphragm, and transversalis fascia. These adhesions may offer almost insurmountable difficulties to safe removal especially of such kidneys as have undergone partial or total suppurative liquefaction. In dealing with such cases, it is always wise at the beginning of the operation to ascertain exactly the point of peritoneal reflection. With this well recognized and in plain view, injury to it is immediately noticed and may be remedied by suture or packing. Similarly, it may be deliberately incised and the relations of a large tumor may thus be definitely gauged by palpation and inspection. A third advantage conforms to Langenbeck's principle that in the excision of large tumors holding close relation to important vessels, before attempting the dissection of the tumor, the surgeon should first lay bare its principal blood supply, thus protecting himself against accidental hemorrhage; and exposure of the retroperitoneal space opens up the most direct route to the renal vessels. Again, if the peritoneum is so closely adherent to the anterior aspect of these kidneys which have undergone chronic suppuration, either tuberculous or pyogenic, that its separation is impossible, this portion of peritoneum should be excised and the aperture closed either before or after ligating the pedicle. Nephrectomy may then be completed by removing the kidney and both fibrous and fatty capsule. In tuberculous kidneys, unless early, and kidneys the site of neoplasms, this is essentially the rule, as the infection of a remaining fatty capsule by either is sure to lead to recurrence. Where the tumor is of moderate size, this may be easily accomplished, or at least with moderate difficulty. Unfortunately, this is not always the case, and adhesions to the diaphragm, colon, and peritoneum may be so tough as to render it well-nigh impossible. If nephrectomy is for a neoplasm, the operation must be persisted in on principle, the surgeon aiding himself with such extension of incisions as is advisable. If, however, the operation is for tuberculosis or long standing pyonephrosis, as more than 50 per cent. of all nephrectomies are, rather than continue a separation of capsule which is dangerous alike to peritoneum, pleura, intestines, and wound healing, through rupture of a pus sac, the surgeon may have recourse to subcapsular nephrectomy.

Subcapsular Nephrectomy.—This operation consists in the enucleation of the kidney from its fibrous capsule and the ligating of the pedicle from within the capsule. This operation is unfortunately more a matter of necessity than of indications. It is absolutely contra-indicated in malignant growths of the kidney; impossible of accomplishment in cases where the capsule forms the wall of a cystic mass, either hydronephrosis or pyonephrosis; and much to be deprecated in tuberculous affections of the kidney where the involvement may have extended to the capsule. When, in the latter cases and in pyonephrotic cases, it becomes evident that division of the adhesions at the upper and lower poles of the kidney will involve tedious and risky dissection or rupture of a pus sac, with its attendant soiling of adjoining large cavities, the subcapsular method of nephrectomy should be employed.

The kidney is exposed as in the preceding operation. If any abscesses present near the surface of the organ, these are incised or drawn off by the trocar and cannula after thoroughly protecting the wound with gauze. The fibrous capsule is then incised along the convexity of the organ, each half picked up with forceps in turn, and with the finger or blunt scissors separated from the parenchyma back to the pelvis of the organ upon which the capsule becomes reflected back, so that a massive pedicle, containing the pelvis and vessels or ureter and vessels, results. This pedicle may then be clamped or ligated en masse, separated and ligated in halves, or the structures ligated individually. Care must be exercised that in a short pedicle no secreting kidney substance is left on the proximal side of the ligature, as a urinary fistula will be sure to result. Only in the shorter pedicles, however, will this be a source of danger. Gerster recommends an ingenious method for ligating the pedicle in any nephrectomy, his description of which follows:

> "A solid rubber cord, pure gum of the best quality, one-sixth of an inch thick and carefully tested, or in an emergency a piece of pure gum rubber tubing, should be selected. A piece about twelve inches in length is passed around the pedicle as high up as possible, in such a way that the middle of the cord will be in contact with the pedicle, each end of the cord being held in one of the hands of the surgeon. While an assistant supports the kidney, the surgeon should steadily and firmly stretch the two segments of the cord, and maintaining the tension, should cross the two 'legs' of the band, the crossing point being in close proximity to the pedicle; at this point another assistant will pass a short piece of stout silk ligature under the point of crossing of the two halves of the rubber cord. Now the surgeon, still maintaining tension, will increase the angle at which the two ends of the cord were held to about 120 degrees, whereupon the silk ligature is firmly tied and the tension of the cord released. The result will be that the parts of the cord thus released will shorten, thicken and will

crowd up against the silk ligature while the segment confined within the silk ligature and embracing the pedicle will remain at utmost tension. It cannot slip, it will remain tense to the end, while slowly cutting through the pedicle, and is the simplest and most dependable form of ligature known. It is far preferable to silk or catgut, both of which will soon become loose if applied to a stout and edematous pedicle. The simple method of securing the rubber band with a silk ligature was tested by me hundreds of times without accident, and is much better than a knot tied in the rubber cord itself. It is especially useful where a pedicle of extreme shortness cannot be exposed to sight and where the trick must be done in the depth of a narrow cleft. The ends of the rubber cord and silk ligature are brought out through the angle of the wound left open for drainage. The length of time required for the coming away of the rubber ligature varies from twelve to thirty-six days, depending upon the thickness and solidity of the structures composing the pedicle."

This rubber cord ligature is never used, however, when the pedicle can be easily exposed and its vessels ligated individually. In such individual ligation of the vessels of the pedicle, it is always best to tie and divide the vein first, and then the artery. The reverse procedure is apt to put too much tension on the more delicate walls of the vein, a tension which may easily result in rupture of the wall or a tearing through by the ligature.

The kidney having been removed, such portions of the fibrous capsule as may easily be dissected away from within the cavity should be removed, drainage inserted, and the wound closed as in extracapsular nephrectomy.

Even with the utmost care in nephrectomy, whether extracapsular or subcapsular, there will be times when the condition of the patient or the exigencies of the operative procedure demand the seizure of the pedicle in from 1 to 3 clamps which have to be left in situ for hemostasis. When this is necessary, these may be gently loosened about the third day, leaving them still in position as a precautionary measure, and if no bleeding occurs, they may be carefully removed the following day. While clamps in the wound may not appeal to the esthetic sense of the surgeon, their use has saved many a precarious situation to the great credit of the surgeon.

Nephrectomy for Malignant Growths of the Kidney. Nephrectomy for malignant growths requires a few words in addition to what has been said above. While in a few cases, partial nephrectomy may result in cure, in general the rule to adopt is to make the same wide excision in new growths here as in any other part of the body. Incision should be wide and exposure of the kidney especially free. It is in this type of case that **combined lumbar and abdominal nephrectomy** finds itself most frequently indicated.

When, from the size and nature of the growth, it has been decided that nephrectomy by the lumbar route alone is unsafe and unwise, 2 courses are open to the surgeon. The first, well adapted to moderate sized new growths in a patient with a small iliocostal space, is the prolongation forward of the horizontal side-splitting incision mentioned in the section on incisions. This will, as a rule, give room enough for the removal of any large kidney. The posterior lumbar exposure enables the surgeon to free the kidney posteriorly from its fatty capsule. Anteriorly in the wound the peritoneum, when not involved, may be pushed forward unopened, and the pedicle of the kidney thus reached and ligated, or, if the kidney is too large and the peritoneum has become so attached that its removal is necessary as a part of the operation, the peritoneal cavity at the mesial end of the incision may be opened, the small intestine and colon pushed toward the opposite side of the abdomen, and the peritoneum again divided longitudinally at the outer side of the colon, thus mobilizing this and enabling the surgeon to carry it far enough toward the mesial line so as to expose the pedicle of the kidney. The pedicle is then tied and enucleation of the kidney and its removal completed. Where such enucleation is done before ligation of the pedicle, it must be remembered that the large veins which run over the surface of the tumor may necessitate division between ligatures and the formation of several accessory pedicles. Having removed the kidney by enucleation, the fatty capsule may be removed in part or in whole. In this it is of utmost importance to remember the location of the vena cava and the relations of the kidney to the duodenum, the hepatic and splenic flexures of the colon. The attachment of the last to the diaphragm gives it an intimate relation to the anterior surface of the kidney, to which it may become closely adherent. The duodenum on the right side may similarly be a great source of worry. Should the adhesions at the upper pole of the kidney be so firm that separation is difficult and dangerous, added room and exposure of this part of the operative field should be gained by excision of the last or 2 lower ribs. Following removal of the kidney, the renal vein and inferior vena cava should be examined for any thrombi. Israel advises the removal of these, even if it is necessary to temporarily clamp the vena cava. The cavity left by removal of the kidney and the fatty capsule should then be thoroughly reviewed, the peritoneum repaired, drains inserted according to the size of the cavity and the prospective oozing, and the wound closed. Usually, unless a combination of new growth and infection has been met, drainage may be removed by the fourth or fifth day.

While the above procedure will meet practically any indications in the exposure of a new growth of the kidney, Morris recommends a double incision. First an incision in the linea semilunaris of the affected side is made and through this the topography of the organ to be removed is studied by palpation. A lumbar incision is then made, and the kidney is separated from its capsule behind. The patient is then put back in the dorsal position, and the kidney exposed by incision of the peritoneum along the outer border of the colon, as described above. According to the size of the vessels connected with the tumor, ligature of the pedicle is done either now or later. The kidney is freed at both poles and in front, and is delivered through the abdominal wound by pressure in the lumbar wound, the ureter still attached. This is then severed as low down as possible, the peritoneal cavity and abdomen are entirely closed, and drainage is instituted through the lumbar wound, which is then closed.

Abdominal Nephrectomy.—Abdominal nephrectomy has, at the present day, its only indication in the removal of the larger solid tumors of the kidney. Incision (Langenbeck) is made in the linea semilunaris of the affected side. The outer leaf of the mesocolon is opened by a small incision, enlarged by tearing, and thus the vessels going to the colon in the inner leaf are for the most part avoided. With the fingers, the kidney is then separated from its surroundings as far back as the hilum, and a double ligature is passed about the vessels of the pedicle, leaving out the ureter. The separation of the organ is then completed. This may be accomplished only with great difficulty when adhesions are numerous and many ligatures may have to be applied. The kidney is then delivered through the abdominal wound and the ureter divided by any of the methods already suggested. The cavity left by removal of the organ is then carefully looked over for bleeding points, and these are ligated. Drainage is instituted by a counter opening in the lumbar region. The blunt scissors or forceps are forced through the muscles to a point just external to the quadratus lumborum muscle, and here incision is made through the skin. This incision is just large enough to accommodate the necessary drains. The point of a clamp or forceps may then be used to seize and pull through the counter opening the tubes or gauze necessary. The peritoneum is closed and the abdominal wound sewed up tight. This operation has practically no place in the surgery of the kidney to-day, except to meet those rare new growths of very large size or those affections of absolutely misplaced or floating kidneys with a mesonephron.

Dangers of Nephrectomy.—The dangers which accompany nephrectomy are many and harassing, especially to the surgeon of little experience, and particularly is this true when it is necessary to remove a kidney which has already been the site of a previous nephrotomy or nephrostomy. In spite of the indications as roughly outlined above, many times will arise when the operation of theoretical choice must give way to practical judgment, and the only indications then important are given by the conditions as confronted after incision is made.

The dangers of a nephrectomy are not alone those common to any major operation, but there are several special and important enough to be separately mentioned. Shock from excision of an organ so close to the solar plexus may occur. Hemorrhage, either primary or secondary, may arise from the slipping of clamp or ligature; from the retraction of vessels apparently caught and ligated in a pedicle so fibrous or so thick and short that a ligature en masse will not hold the individual elements; or from direct severing of aberrant vessels or the tearing away of normal vessels. In spite of the utmost care, such accidents will occasionally occur to the best of surgeons. When met with in the bottom of a deep wound or in the excision of a large tumor which totally obscures from view the pedicle and its vessels, such an emergency is far better met by locating and grasping the pedicle with the fingers than by blind efforts to grasp it with long clamps. It is surprising, but true, that a spurting renal artery will practically guide the fingers to itself by the outrush of blood and will almost leap into the fingers in its pulsations. Suffice it to say, however, that such guidance must be quickly followed and that the sense of relief that accompanies the accomplishment of the desired end is surpassed by few other efforts at hemostasis. Hemorrhage from a tear, by traction or clamping the vena cava or aorta, is far better avoided than remedied. When occurring, if possible, the vessel must be either sutured or ligated. In ligating the renal vessels it is well to remember Gerster's suggestion that ligation of a vein should precede ligation of an artery.

Wounds of the pleura give their own note of warning by the sibilant sound emitted on inspiration and expiration. They are easily sutured and surprisingly free from untoward results. Wounds of the peritoneum, on the other hand, are dangerous if unrecognized. Made deliberately in the course of an operation, they may be easily repaired; but made unintentionally in the separation of a pus kidney, they may lead to a fatal peritonitis.

Wounds of the gut should be repaired as soon as made and covered with the peritoneum or omentum. When made at the time of operation, convalescence may be unretarded. When resulting from the pressure against the colon of misplaced drainage tubes or from the clamping on the right side of a small piece of duodenum with the pedicle, the result may be either a long standing fecal fistula in the first place, or a short running, rapidly fatal, duodenal fistula in the second. These latter seldom show themselves until a few days—4 or 5—after operation. Usually they are the result of clamping a short sclerosed pedicle and catching in the ends of the clamp the duodenal wall, with subsequent necrosis of this wall. The resulting fistula means rapid death from inanition and exhaustion as, owing to the gastric, intestinal, pancreatic, and biliary secretions present, there is no tendency to spontaneous healing, but rather a progressive enlargement of the fistula. Mayo strongly urges in such accidents, before the exhaustion of the patient, a transperitoneal attack on the duodenum, lifting it from its bed, suturing the fistulous opening, covering it with the peritoneum or omentum, followed by a jejunostomy for artificial feeding for a few days.

Anuria following nephrectomy calls for immediate nephrotomy on the other side.

In general, the other sequelæ or complications are the same as those met with in any major operation on a possibly infected organ, and must be treated according to their individual indications.

OPERATIONS ON THE PELVIS OF THE KIDNEY

PYELOTOMY: PYELOLITHOTOMY

Pyelotomy or pyelolithotomy is an operation which was formerly approached with considerable misgiving as to its ultimate results, but which has rapidly gained favor in the past few years with the greater certainty of diagnosis made possible by the X-rays and by ureteral catheterization with possibly subsequent X-ray. Compared with nephrolithotomy, it has the disadvantages that (a) complete exploration of the kidney by sight is impossible; (b) large branching stones or stones in the calices are removed with difficulty; (c) when pus is found and drainage becomes necessary, fistulæ are apt to result and persist. The first of these objections has largely been eliminated by our more certain methods of diagnosis. A very large branching stone may better be removed by nephrolithotomy, but certain it is that exploration of the calices and removal of stones from them is not very difficult. Where pus is present and drainage for a considerable time is necessary, nephrolithotomy may better be done. In clean cases and in cases of smaller stones in the pelvis of the kidney, pyelotomy is the operation of choice. It avoids hemorrhage, does not injure the renal parenchyma, and is quick to heal in clean cases, with practically no danger of a fistula resulting.

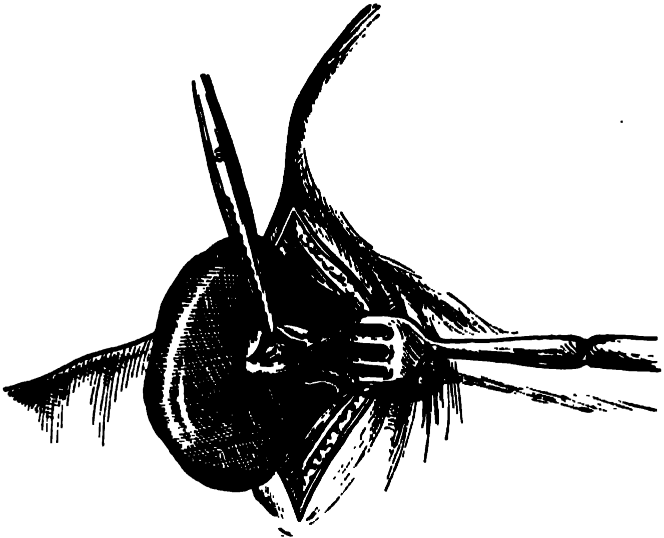


FIG. 24.—POSTERIOR WALL OF PELVIS OF KIDNEY INCISED LONGITUDINALLY EXPOSING A SMALL STONE.

Technic.—The kidney is exposed by the lumbar route in the same way as for nephrolithotomy, and if possible is delivered upon the back or well into the wound. The posterior wall of the pelvis is thus exposed. If palpation has revealed the location of the stone, the pelvis is incised over it, but not too close to the renal parenchyma. If exploration must be made, the line of incision corresponds closely to the mid-line of the pelvis in a direction toward the ureteral orifice. The little finger is then introduced, and the pelvis and calices explored. Finding the stone, it may be delivered through the wound—if small, picked out of either pelvis or calyx by stone forceps or a curette; or, if large, the incision in the pelvis may be prolonged into a large opening or into a flap opening. While it is better to avoid the region of the parenchyma, when possible, on account of the greater difficulty of placing the closing sutures, it is not necessary if, by making a flap incision, a large calculus can thus be removed without comminution. If lavage of the pelvis seems necessary, it is done. The ureter is explored as in any kidney operation. The pelvis is then ready to close.

If care has been taken in the exposure of the pelvis not to remove the fine-grained fatty tissue or inner layer of fatty capsule which is closely attached about the pelvis and sinus, this will be found of great aid in closure of the wound, especially in cases of stones of considerable standing, when this fatty covering is apt to be thickened to some extent. The Mayos consider this fatty fascial flap of the utmost importance as a covering after operations upon the pelvis of the kidney, and as a means of protecting the suture line in the pelvis of a kidney which has been operated on for the purpose of removing stones.

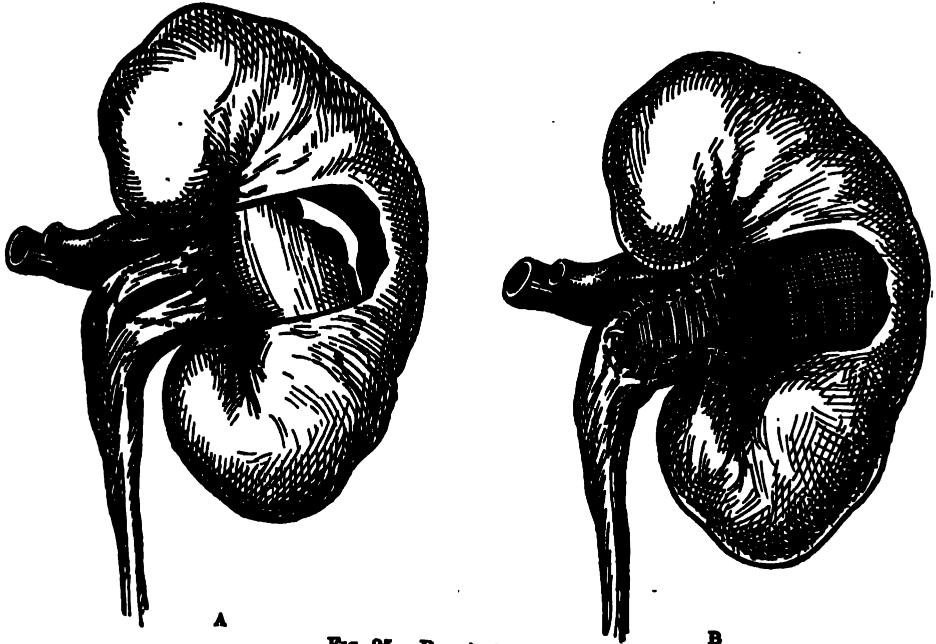


FIG. 25.—PAYR'S OPERATION.

When the pelvis is exposed, care is taken that the attached fat is not removed, but incision is made directly through it as a part of the wall of the pelvis, and in closing the wound, it is sutured as a part of the pelvis wall with No. 1 catgut. Even if co-aptation is imperfect, no leakage occurs.

If the opening in the pelvis is large and ragged, a small flap is made from this fascial covering and, after closure of the incision into the pelvis, this flap is brought across the line of suture and held in place by 2 or 3 sutures of fine plain catgut to keep the parts in apposition. Apposition of the flap and the pelvis is important. Close approximation of the incised pelvic wall edges is not necessary to healing by primary union. In a number of cases, where the closure of the wall of the pelvis was not urine tight but was covered with the fatty fascial flap, Mayo (2) found that healing took place with no leakage. This lack of leakage has enabled the surgeon to substitute pyelotomy for nephrolithotomy in many cases of stone in the pelvis. In cases where temporary drainage of the kidney pelvis is deemed necessary, this is best accomplished by the use of a small soft rubber tube placed so that it enters the pelvis not at right angles to the pelvic wall but parallel to this wall after the manner of inserting a gastrostomy tube. While it is impossible to overlap the wall of the normal sized pelvis over such a tube, the fatty fascial flap may be so brought over that, on removal of the tube, it tends to fall together and obliterate the opening, thus avoiding the tendency toward formation of a long persisting fistula. Where primary closure of the incision in the pelvis is practicable, the method of Mayo and the use of the fatty fascial flap will be found most advantageous. Should such a flap be found impossible, due to deficiency in this layer or to its complete removal in the course of exposure of the pelvis, Payr has suggested the dissection off and turning back of a small flap of the fibrous capsule from the posterior surface of the kidney and its approximation over the line of pelvic suture by a few catgut sutures.

As in nephrolithotomy, even more so in pyelotomy, is the absolute removal of foreign bodies, such as blood clots, fragments of comminuted calculi or small pieces of pyogenic membrane, essential to the quick union of the pelvic wound. So, too, for drainage, the ureter must be ascertained to be free and unobstructed and opening into the most dependent portion of the pelvis. As in nephrotomy, the passage of a ureteral catheter into the pelvis of the kidney and its replacement by a slightly larger catheter drawn through from above may establish the temporary drainage necessary for primary union in the pelvic wall. These individual indications having been met, the lumbar wound is closed in the same manner as previously described, i. e. a 3-layer muscle repair and a skin closure.

PLASTIC OPERATIONS IN THE KIDNEY PELVIS

Plastic operations in the kidney pelvis are indicated in small hydronephrotic sacs under certain conditions, in intermittent hydronephrosis and in strictures or occlusions of the first part or orifice of the ureter. Many of these operations have met with marked success. Most of them are done following nephrotomy and the thorough exploration of the kidney itself, together with its pelvis and ureter. In all exposures of the kidney it is by any one of the usual lumbar incisions, following which exploration ascertains the exact condition with which the surgeon must deal.

Plication.—Plication of the pelvis of the kidney, as done by Israel in 1896, and by Albarran[1] in 1898, is the simplest of the plastic operations on the pelvis of the kidney. It presents a method of reefing up by suture the wall of a pocket which has developed below the level of the ureteral orifice. The success of the operation must depend upon a normal sized ureteral opening, a free and unob-

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[1] Albarran, p. 223, Fig. 102; pp. 224-225, Figs. 103 and 104.

structed ureter, and ability to so obliterate the pocket that the urine flows freely and unobstructedly into the ureter. The surgeon places in the wall of the pocket a series of sutures of plain catgut in such a position that when tied, they completely obliterate the dependent pocket to a level with the ureteral orifice. Before tying such sutures, the wall of the pocket may be lightly scarified, the better to promote union. After tying, the finger in a nephrotomy wound ascertains the obliteration of the pocket. If any small pockets remain, these are occluded by the insertion of additional sutures. On completion, the finger in the pelvis should feel a smooth floor level with the mouth of the ureter.

Ureteropyeloplasty.—Ureteropyeloplasty is an operation devised by Fenger in 1892 for the relief of stricture at the mouth of the ureter and intermittent hydronephrosis. The operation is in reality a Heinike-Mikulicz pyloroplasty adapted to this situation. A longitudinal incision is made through the line of stricture, if necessary, extending into the pelvis above, having previously introduced through the stricture a small sound or catheter to act as a guide. The lips of this incision are then separated transversely and the wound closed in a transverse direction by interrupted sutures of fine plain catgut (Fig. 27). The resulting caliber of the opening should permit of the introduction through the site of a No. 14 F sound. The suture line may then be reinforced by the opposition to it of a fatty fascial flap after the manner of Mayo.

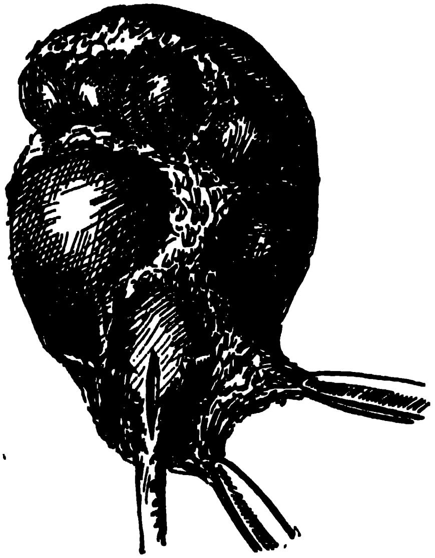

FIG. 26.—LONGITUDINAL INCISION THROUGH A STRICTURE AT BEGINNING OF URETER EXTENDING INTO PELVIS OF KIDNEY.

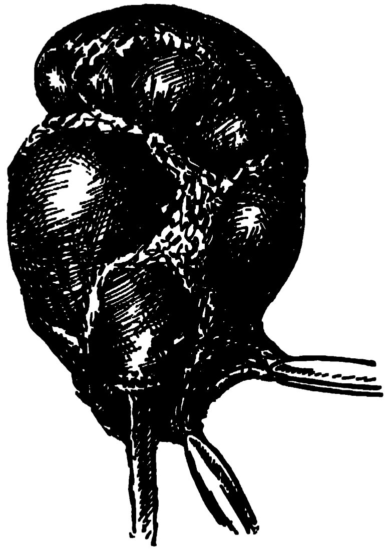

FIG. 27.—LIPS OF LONGITUDINAL INCISION SEPARATED TRANSVERSELY AND WOUND SUTURED IN TRANSVERSE DIRECTION.

Ureteropyelostomy.—Ureteropyelostomy, first practiced by Trendelenburg and Küster, comprises the section of the ureter at its terminal part and its anastomosis to the most dependent part of the renal pelvis. This operation is indicated in strictures or constriction of the ureteral orifice, in valve-like torsions of the same, as the result of adhesions or cicatrization, in accidental resections of this portion of the ureter, or in hydronephrotic conditions where the new anastomosis may reëstablish dependent drainage. Following nephrotomy or pyelotomy, the internal orifice of the ureter is sought with a small bougie or sound, and the anatomical and pathological conditions ascertained. Frequently in such cases it is necessary to pass the bougie from below upward into the pelvis of the kidney through a small ureterotomy wound. The ureter at the pelvic end is then ligated and sectioned. If a stricture extends some distance in the tube, it may be necessary to resect from 1 to 2½ in. The latter, however, represents about the limit in which resection and terminal anastomosis may be accomplished. The free end of the ureter may now be sectioned obliquely, or, if already sectioned transversely, may be cut down about ½ in. along its longitudinal axis on one side and the corners rounded off. The most dependent part of the pelvis is then incised to the same length as the ureteral orifice, and bringing the 2 openings together, anastomosis may then be effected after the manner of a gastrojejunostomy, by a running stitch of fine plain gut, first through the contiguous edges of the ureter and pelvis, tying at either end to prevent pursestringing, thence back through the separated walls. A fine Lembert or Cushing suture may reinforce this, apposing any fatty capsule which overlies the pelvis to the suture line. Care must be exercised that the ureteral or pelvic wall is not grasped by clamps, as the pressure from these may cause later necrosis of a small portion of the wall and destroy the integrity of the anastomosis.

Albarran suggests the excision of a small triangular piece from the most dependent portion of the pelvic wall instead of making a mere slit through the wall. In the opening thus made, he interposes the sectioned end of the ureter, making a careful suture of the mucous membrane of one to the other. Thus closed, he applies to the outside several sutures of the type of Lembert to reinforce and sustain the principal mucous membrane suture.

Where the operation is done for a torsion or stricture purely at the ureteral orifice, the ureter may not be sectioned, but the part below the stricture brought into apposition with the pelvis at its lowest point and a lateral anastomosis performed. The section of the ureter involves no danger, however, and the enlargement of the ureteral orifice by oblique sectioning of it is a distinct advantage; hence, the first plans of anastomosis are to be preferred. Drainage in such anastomosis will be considered necessary in many cases, but the utmost care should be taken that such drainage exert no pressure upon the immediate line of suture.

SURGERY OF THE URETER

In the consideration of the surgery of the ureter, a few general remarks may not seem amiss.

It should be remembered, in the first place, that the ureter is a small, delicate tube having an extremely small diameter, and that best results are to be obtained by the employment of fine, delicate instruments, reinforced by extreme care, gentle handling, and a due consideration for its blood-supply, which is at times uncertain.

It should also be borne in mind that the ureter has in its environment numerous important structures during its course from the pelvis of the kidney to its junction with the bladder, and that proper realization of its anatomical relations, together with their importance, is essential for the best results.

Anatomical Points.—At their commencement, the 2 ureters are about 3 in. apart; they descend downward and inward behind the peritoneum to the bladder, where they are separated some 2 in. from each other; they then traverse the wall of that organ obliquely, terminating upon mucosa from ¾ to 1 in. distant from each other. In their course they are in close relationship to the large intestine, inferior vena cava (on right side), genitocrural nerve, common iliac (or external iliac), and, in the female, the uterine artery. This latter artery should always be carefully considered in performing a hysterectomy, especially the complete removal of the uterus. A fairly accurate surface landmark of the position of the ureters from the kidney to the pelvic brim may be obtained by erecting a perpendicular at the junction of the middle and inner third of Poupart's ligament. Likewise, the position of the crossing of the ureter over the pelvic brim may be approximately determined by the intersection of a line drawn vertically upward from the spine of the pubis, with one connecting the anterosuperior spine of the ileum.

EXPOSURE OF URETERS

Exposure of the ureters may be obtained either retro- or transperitoneally. The former is the procedure of choice and the one more frequently resorted to. The transperitoneal route is employed, as a rule, for operations low down in the pelvic portion of the ureter, or where injury occurs or operation is decided upon, during the course of a laparotomy.

Retroperitoneal Route

1. **Oblique Lumbo-iliac Incision.**—By this incision the upper ¾ of the ureter, and in some instances more, can be exposed. The incision, which is extensive, starts just below the twelfth rib at the angle of its junction with the outer border of the erector spinæ; passes obliquely downward 1 in. internal to the anterosuperior spine, then downward and inward ¾ in. above and parallel to Poupart's ligament, terminating at the outer border of the rectus. The intervening muscles are incised down to the peritoneum, which is retracted inward, thus pulling with it the ureter, which usually adheres closely to it. In the lower portion of the wound, the ascending colon (on the right side) and the descending colon (on the left side) will likewise be retracted inward.

In operations on the lower section of the ureter and on its brim, the lower portion of the above incision may be all that is necessary, the incision starting 1 in. inside of the anterosuperior spine of the ilium and slightly above it.

2. Gibson's Incision.—This incision begins in the median line 1 in. above the pubis, and is carried through the skin, through the aponeurosis of the external oblique and the muscle of the internal oblique, being parallel to and 1 in. above Poupart's ligament; it ends at, or slightly above and internal to, the anterosuperior spine on the same side. The muscles are retracted upward and the transversalis fascia incised, the peritoneum being pushed upward and the rectus inward, thus exposing nicely the pelvic portion of the ureter.

The patient should be placed in the Trendelenburg position. This incision offers excellent exposure with a minimum damage by muscle cutting.

3. The Transrectus Incision.—A good exposure of the lower portion of the ureter is also obtained by a transrectus incision, starting at the level of the umbilicus, and extending downward to the spine of the pubis. The skin, superficial fascia, and anterior rectus sheath are incised; the fibers of the rectus separated; the transversalis fascia cut; and the peritoneum then reflected upward and inward. Remember that the deep epigastric artery and vein run between the transversalis fascia and peritoneum in the course of this incision, and must be sought and tied off.

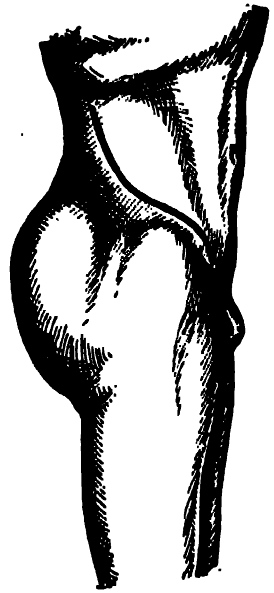

FIG. 28.—OBLIQUE LUMBO-ILIAC INCISION.

4. Median Abdominal Incision.—Judd has recently described a retroperitoneal route for the exposure of the lower fourth of the ureter. The incision starts just below the umbilicus in the median line, and extends to the pubis, traversing the skin, superficial fascia, and linea alba. The recti are retracted; the transversalis incised; the peritoneum pushed upward off the bladder; the bladder pulled out of the wound, after being loosened from its bed; and the ureters exposed as they enter the bladder. This same exposure may be obtained by the Pfannenstiel incision, which will be described under transperitoneal routes.

TRANSPERITONEAL ROUTES

The transperitoneal routes are the same as for a laparotomy for the purpose of exposing the pelvis, and are usually employed in operations low down in the ureter. The incisions usually employed are either median, transrectus, or the Pfannenstiel incision. The latter is a curved skin incision with its convexity downward, extending just above the pubis laterally across the 2 lower ends of the recti muscles. The incision is then deepened to include the anterior rectus sheath, which is then dissected upward off both the recti muscles as one flap, and then retracted. The recti are separated and the transversalis and peritoneum are opened by a vertical incision.

OTHER ROUTES

Various operations have been devised for exposure of the lower end of the ureter through the vagina and the peritoneum, but they offer so many drawbacks in the matter of difficulties in technic, infection, etc., that they have been abandoned and so will not be described, inasmuch as they are not recommended.

URETERORRHAPHY: SUTURING OF THE URETER

Suturing of the ureter is usually done for repair of wounds or following incision for removal of calculi. Here fine needles must be used and fine suture material employed, either silk, small chromic catgut, or linen thread. The suture should not include the mucosa, but only the fibrous and muscular coats (see Fig. 29), and should be interrupted and reinforced, if possible, by a second row or a Lembert suture, always keeping in mind the possibility of occluding the caliber of the ureter by the employment of too many rows of sutures. This operation should be done retroperitoneally where possible. If this is out of the question, the peritoneum should be carefully sewn over the suture line to reinforce it after completion of the operation.

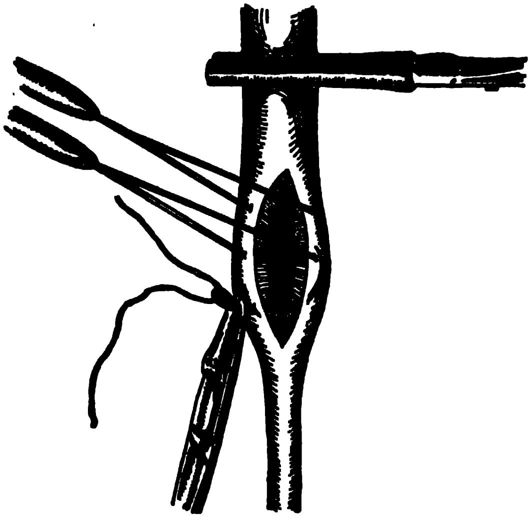
FIG. 29.—SUTURING URETER WITH INTERRUPTED SUTURES INCLUDING FIBROUS AND MUSCULAR COATS BUT NOT MUCOSA.

Wounds of the ureter may be divided into complete and incomplete. They may be oblique, transverse, or longitudinal, and they may be clean-cut or frayed. They are most commonly the result of injury during a laparotomy, and they call for some immediate remedy.

In complete wounds, some form of anastomosis must be done, or implantation of the proximal end into some viscus, although in many cases of this injury the ureter has been simply ligated without any apparent baneful sequelæ.

In incomplete wounds, some attempt should be made to suture the opening in order to avoid a persistent fistula or subsequent cicatricial contraction with stricture and renal retention.

In longitudinal wounds, where the danger of stricture is feared, the procedure adopted is that described under Stricture of Ureter. In many instances, however, this type of wound often heals spontaneously without any leakage.

In transverse wounds, a longitudinal incision, ⅛ in. long, should be made at the central point of the transverse wound, on either side, i. e., one extending upward and one downward, passing through the entire thickness of the ureteral wall (Fig. 30). The sutures are placed as follows: One starts at the upper angle of the upper longitudinal incision and comes out at the lower angle of the lower longitudinal incision; then 2 sutures are placed on either side (Fig. 31). This maneuver produces a longer transverse incision than the original one and decidedly offsets the possibility of stricture.

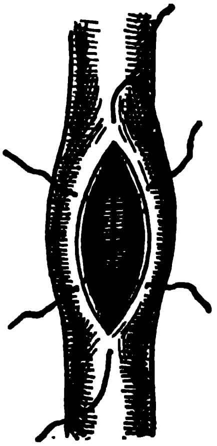

FIG. 30.—SUTURING LONGITUDINAL INCISION. One suture starts at the upper angle of the wound and comes out at the lower angle, the other sutures are placed on either side.

Oblique wounds are brought together with interrupted fine chromic gut in the usual manner of suturing.

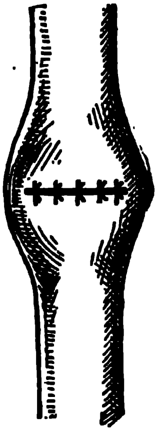

FIG. 31.—SHOWING THE SUTURES LIGATED.

URETEROTOMY: INCISION OF THE URETER

Ureterotomy for Calculus.—Ureterotomy is usually done for removal of calculi and may then be termed "ureterolithotomy." If choice of route is possible, the retroperitoneal method is the better one. The calculus having been located by ureteral catheterization or X-ray, the ureter is exposed, freed if necessary, and protected clamps or temporary ligatures placed above and below the site of operation to prevent soiling or displacement of stone, and the ureter drawn forward. The field is protected by gauze and a longitudinal incision made directly over the calculus, which is removed by forceps, a small scoop or other convenient instrument. After removal of the calculus, the wound is sutured as above described.

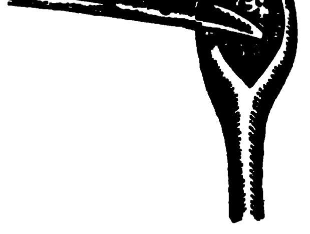

FIG. 32.—LONGITUDINAL INCISION IN THE URETER MADE DIRECTLY OVER THE CALCULUS.

Drainage will depend upon the character of the urine, the technic employed, and the difficulties attending the placing of suture, which often occur in the lower portion of the ureter. In the latter instance, good results have been obtained without suture by simple drainage.

Ureterotomy for Stricture.—The site of the stricture is first located by catheterization of the ureters, the catheter being allowed to remain in situ. The stricture is exposed by the retroperitoneal route, and the ureter clamped above the site of the stricture. A longitudinal incision is then made through the stricture, including all coats. The catheter is then pushed up the ureter, slightly above the stricture, and the sutures placed, the object being to make the longitudinal incision a transverse one (Fig. 33). The first of the 3 sutures usually employed is passed through the muscular and fibrous coats without taking in the mucous membrane, the needle entering at the upper angle of the incision and coming out at the lower angle in such a manner that when the suture is tied the angles are brought in apposition, thus making the wound a transverse one and enlarging thereby that portion of the ureter which was the seat of stricture. Two other similarly placed sutures are employed on either side of the one just described (Fig. 33, B), producing the suture line illustrated in Figure 33, C.

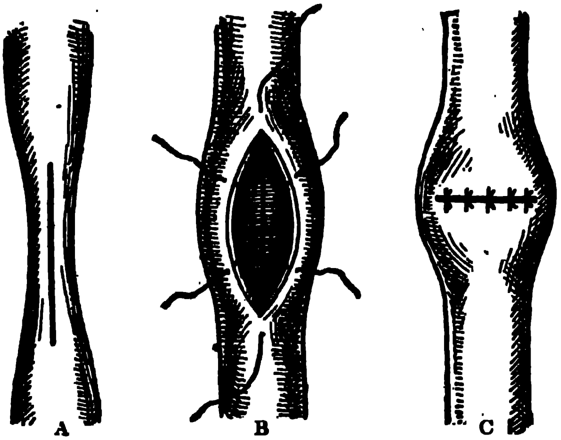

Fig. 33.—A, Longitudinal Incision Through the Narrowed Ureter. B, Sutures Placed in Long Axis of the Ureter. C, Sutures Being Tied Make Wound Transverse.

Drainage is usually employed. The catheter may be left in for a few days to reduce the chances of leakage.

URETERO-URETEROSTOMY: ANASTOMOSIS

Anastomosis is resorted to when the ureter is completely severed. The 3 operations which are commonly employed will be described: Poggi-Robson, Van Hook and Bovee, together with a reference to end-to-end anastomosis. Of these, Van Hook's method is probably the best for all around use, although about 1½ in. of length of the ureter is sacrificed in its performance. End-to-end anastomosis shortens the ureter about an inch, and is apt to be followed by stricture and leakage, the latter being also a likely result of end-to-end anastomosis.

Poggi-Robson Operation.—The ureter is exposed, loosened freely from its bed, and the proximal and distal ends clamped at some distance from their extremities. The operative field is thoroughly protected with gauze.

The object of the operation is to invaginate the proximal end into the distal, and is performed as follows: A longitudinal slit, involving all coats of the ureter, is made ⅙ in. long on the anterior aspect of the lower segment, in order to enlarge its caliber for receipt of the upper segment. A plain catgut suture is next introduced ⅛ in. above the cut margin of the upper segment on its posterior aspect, and is then carried through the posterior wall of the lower segment the same distance (⅛ in.) from its cut edge (Fig. 34, A). The upper segment is then pulled into the lower segment, and the suture tied, after which the anterior slit of the lower segment is sutured and the margin of the lower segment sutured also to the adjacent circumference of the upper segment by fine chromic sutures, as shown in Figure 34, B. Drainage should be employed as leakage is quite possible.

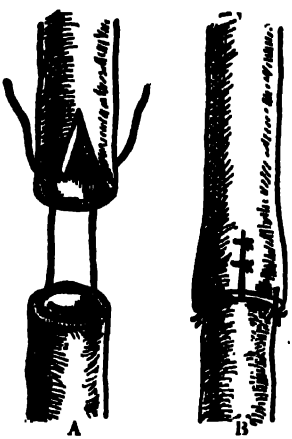

Fig. 34.—Poggi-Robson Operation.

Van Hook's Method.—In this operation considerable shortening of the ureter is necessary, the object being to bring the end of the renal segment into the lateral wall of the vesical segment, and then suture it in place. The ends of the ureter are clamped as in the previous operation, and the lower end of the ureter circularly ligated with silk ⅛ in. from its cut margin. One-quarter inch below this ligature, make a longitudinal slit involving all coats and equal in length to the diameter of the ureter (Fig. 35, A). Next make a longitudinal slit in the

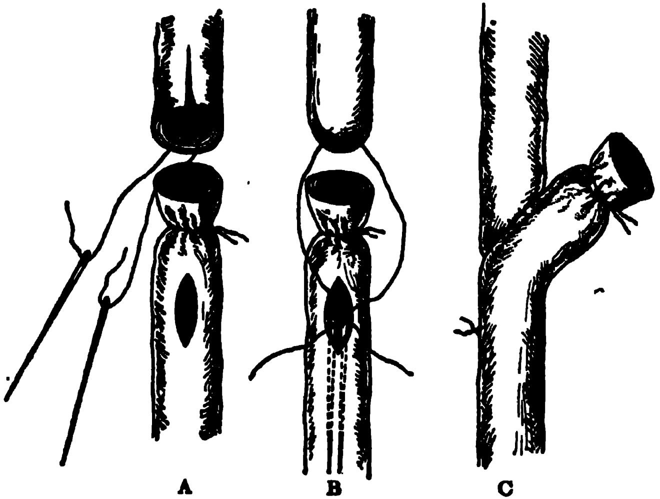

Fig. 35.—Van Hook's Operation.

proximal segment, beginning at its cut end and extending upward ¼ in. A traction suture of catgut is then introduced in this same segment ⅛ in. from the cut margin on the lateral aspect, opposite the slit in the lower segment, and the ends of this suture are brought through the slit of the lower segment; then, traversing the lumen for ¼ in., they are brought outward through the ureter wall on the same side as the slit through which they passed (Fig. 35, B). Next draw the upper segment into the lower one through the slit, until the slit in the upper segment is well within the lower slit and facing the opposite aspect of the wall. The traction suture is then tied and the operation completed by suturing the vertical slit in the vesical end around the circumference of the renal end (Fig. 35, C). If done transperitoneally, suture the peritoneum over the site of the operation and drain retroperitoneally if possible.

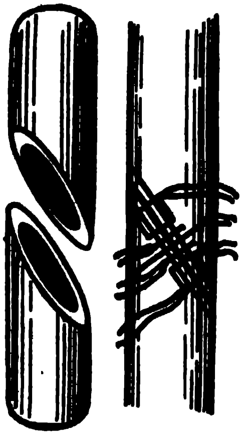

Fig. 36.—Bovee Operation.

Bovee's Operation.—This operation was devised to offset the possibilities of stricture which often results from transverse end-to-end anastomosis, and consists in cutting the ends of the ureter obliquely and approximating their edges by interrupted sutures which penetrate the muscular and fibrous coats only (Fig. 36).

End-to-end Anastomosis.—The divided ends are brought together and sutured by interrupted chromic gut and the anastomosis accomplished either with or without support. If the former plan is adopted, a piece of catheter is introduced into the lumen of the ureter, resting in both the distal and proximal segments, and then interrupted sutures are placed, uniting the ends of the ureter. At the completion of the operation, the catheter is removed through a small incision in the distal segment, and this opening is then closed by suture (Fig. 37).

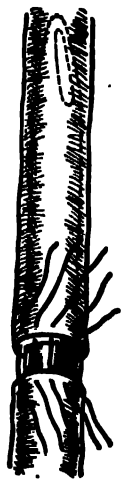

Fig. 37. — Ureter Catheter is Seen Within Ureter Over Which Interrupted Sutures Are Passed Through Outer Coats of Ureter.

IMPLANTATION OF URETERS

In this operation, the proximal end of the divided ureter is implanted either into the bladder, intestine, opposite ureter, pelvis of the opposite kidney, vagina, or skin. The operation, as a rule, is one of necessity, other procedures, as some form of anastomosis, being preferable; but where this is impossible, due either to loss of ureter substance, difficulties encountered, or danger of too great tension on the ureter, one form or another of implantation must be employed or the kidney sacrificed.

The bladder is the viscus of choice into which the ureter is sutured, as implantation into the intestine (sigmoid or rectum), vagina, and skin are fraught with dangers of infection, with subsequent involvement of kidney.*

IMPLANTATION INTO THE BLADDER: URETEROCYSTOSTOMY

Ureterocystostomy is resorted to where great injury or complete division of the ureter is done near the bladder, i. e., during operation for removal of uterus. It is also employed for the cure of ureterovaginal fistula and in malformations, or obstruction in or near the ureteral opening in the bladder. The operation may be performed by 1 of 3 routes: Transperitoneal, retroperitoneal, or transvesical.

1. Transperitoneal Route.—METHOD I.—Median laparotomy, transrectus incision on the same side as the lesion, or Pfannenstiel incision may be employed. The peritoneum is incised, the ureter sought and freed, and the operative field protected by gauze. If not already divided, the ureter is clamped proximally to the proposed incision and divided, the distal end cauterized and tied off. Two slits are then made opposite each other in the proximal end, ¼ in. long, beginning at the divided margin and extending upward parallel to its long axis. Two long sutures of catgut are then placed, 1 on either side of the flaps made by the above slits, these sutures entering the ureter ⅛ in. from its proximal end. The sutures are left long (Fig. 38, A).

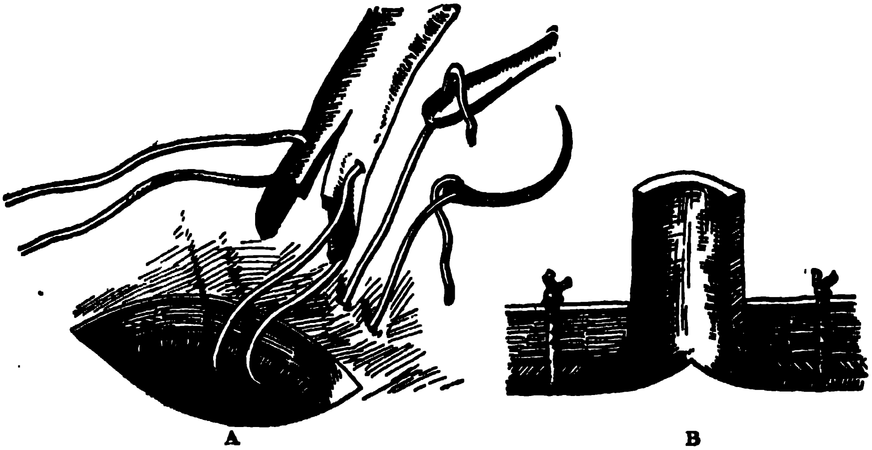

FIG. 38.—TRANSPERITONEAL METHOD IN URETEROCYSTOSTOMY.

Next, a diagonal incision is made through the bladder wall as near the site of the normal ureter opening as possible, and of sufficient size to allow the proximal end of the ureter to be pulled through first, the peritoneum having been incised over the operative field of the bladder. The ends of the sutures, threaded on curved needles, are then carried through this opening into the bladder and made to come out again close to the margin of the wound, 1 on either side of the incision, and tied, thus holding the ureter end open and approximated to the bladder wall (Fig. 38, B).

The incision in the bladder is then closed around the ureter, the sutures penetrating only the muscular and fibrous coats. The operation may be facilitated by introducing a catheter up into the ureter through the urethra and bladder, after incision in the bladder is made.

Leakage may be reduced to a minimum by allowing the catheter to remain for a few days. Drainage should be employed.

METHOD II.—Preliminary steps are the same as above. A small incision, corresponding to the size of the ureter caliber, is made in the bladder after the peritoneum over the bladder has been incised. The proximal end of the ureter is then grasped with a pair of forceps and pushed through this opening sufficiently far to insure that its free end lies just beyond the mucosa. The incision is then sutured around the ureter in the manner described above (Fig. 39, A, B, C).

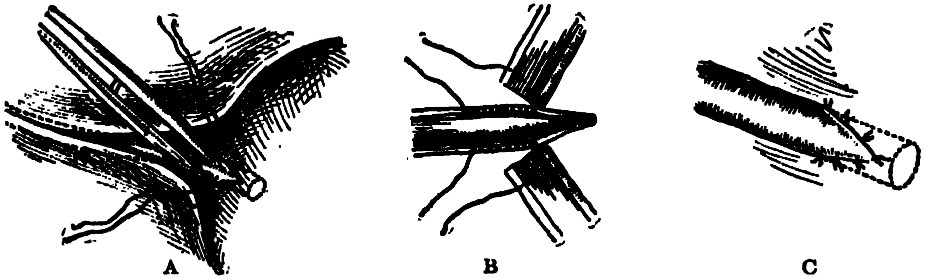

FIG. 39.—URETEROCYSTOSTOMY. A, Cut end of ureter protruding into bladder; B, sutures are passed through outer coats of bladder and ureter; C, ureter sutured into bladder.

2. **Retroperitoneal Method.**—Exposure may be accomplished by the method of Judd, by means of a median laparotomy as described under Incisions.

VAGINAL ROUTE.—This is not recommended, as exposure is difficult, technic complicated, and the dangers of infection great.

3. **Transvesical Method.**—Here, also, there are great dangers of infection, and the operation is not employed as a rule, when other methods are permissible. It is performed by first doing a suprapubic cystotomy; the ureter opening is stretched, and the divided ureter pulled through by forceps, after which the ends of the ureter are slit, and its ends either sutured to the wall of the bladder internally, or sutures carried through the bladder wall and tied externally.

URETERO-INTESTINAL ANASTOMOSIS

Indications.—This method is indicated where vesical anastomosis is for some reason excluded, in (1) removal of bladder, (2) remedy of ureteral fistula, (3) exstrophy of bladder, (4) where the ureter is divided so high it cannot be pulled down to the bladder without undue tension. It should be chosen with a distinct understanding that the mortality due to infection is very high, either from the direct result of operation or from a subsequent kidney infection.

Technic.—The operation is performed by uniting the proximal end of the ureter or ureters to the large intestine, preferably sigmoid or rectum, although the cecum and colon may be utilized. The transperitoneal route should be employed by a hypogastric median incision. The object of the operation is to allow the ureters to open obliquely upon the mucous membrane of the gut in a valve-like manner, in order to lessen the dangers of infection.

FOWLER'S METHOD.—The ureters are sought, freed from their beds, clamped above and cut obliquely as near the bladder as possible, in such a manner that the oblique section is on the posterior half of the ureter end. The distal ends are ligated and cauterized. The proximal ends are then sutured together so that the oblique ends fall posteriorly; the sutures, embracing only fibrous and muscular coats, being interrupted 1 in. from the end of the proximal segment.

Next, select the portion of the gut (preferably the rectum) where the implantation is to be made, planning the incision, which should be placed anteriorly in the long axis of the gut and be 2¾ in. long, so that the ends of the ureter shall conveniently lie at the center of the incision without tension. Incision involves only the 2 outer layers of the rectal wall, the mucous membrane remaining intact. The edges of the incision are retracted and separated well from the underlying mucous layer (Fig. 40, A).

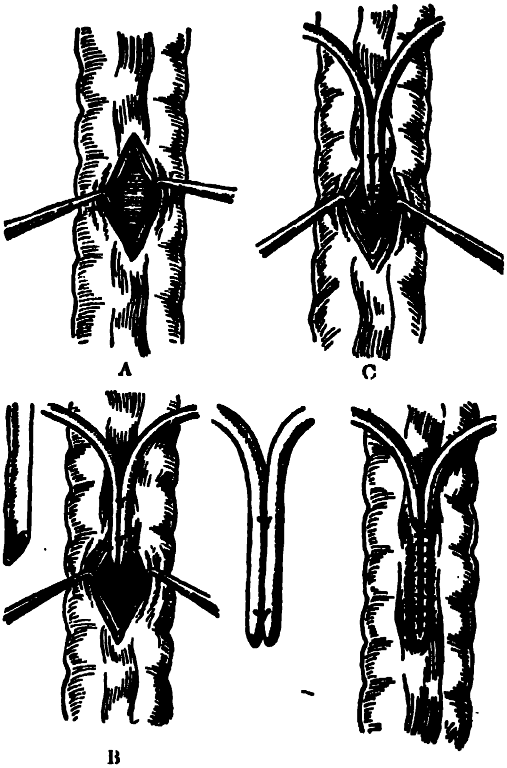

FIG. 40.—URETEROCOLOSTOMY. A, Serous and muscular coats of the colon are incised and retracted, a U-shaped flap is outlined upon the mucous membrane; B, the U-shaped flap is turned upward and the beveled ureters sutured to it; C, ureters buried within the bowel by suturing the mucous membrane over them; D, the serous and muscular coats sutured over the buried ends of the ureters.

Next, a U-shaped flap, with its base uppermost, is turned upward from the lower half of the mucous layer, so that the apex overlaps the base in the upper angle of the wound and is held in place by sutures. The ends of the ureters are now placed upon this upturned mucous flap with oblique cuts posteriorly in direct apposition with the mucous flap, in such a manner as to leave enough mucous membrane below their ends to serve as a valve (Fig. 40, B).

The ends of the ureters are sutured to the mucous flap, and the ureters themselves sutured to the mucous layer in the upper angle of the wound. The opening in the mucous layer caused by the upturned U-flap is closed around the ureters by interrupted sutures (Fig. 40, C).

The ureter ends, with the united U-shaped flap, are then pushed back into the lumen of the gut; the outer wound is closed over them and that portion of the ureter lying obliquely in the upper angle, thus burying them in the rectal wall (Fig. 40, D).

The sutures should also be placed carefully through the outer coats of the ureters and the rectal wall, where the former dip into the bowel. Temporary drainage should be employed.

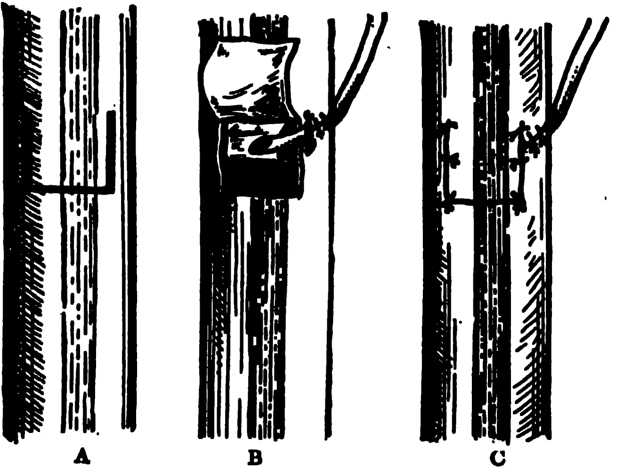

FIG. 41.—URETEROCOLOSTOMY. A; A quadrilateral flap incised through the serous and muscular coats of the colon; B, the outer coat-flap is retracted. The mucous membrane flap of the same size is folded on itself and fastened. The ureter is buried in the wall of the colon, the end sutured to the mucous flap; C, the outer coat-flap is brought down in place and sutured.

METHOD II.—The same purpose may be accomplished by the following operation, which aims at an oblique transplantation with somewhat different technic. The preliminary steps are the same as above. After the ureter has been cut across and freed, a quadrilateral flap, 2 cm. long and 1 cm. wide, is made on the anterior surface of the gut, involving the serous and muscular coats; the incision only embracing the 2 sides and lower aspect of the quadrangle, the upper end being undivided where the flap is turned up as on a hinge (Fig. 41, A).

The mucous surface is then divided in like manner and turned upward and outward, the lower edge being held in position at the base of the flap by sutures, thus forming a mucous valve. The ureter is next brought to the lateral aspect of the gut on a line with the upper limit of the opening in the gut, and sutured obliquely to the gut wall in such a manner that its end rests upon the previously formed mucous valve (Fig. 41, B), and is then embedded in the gut wall by suturing the peritoneum and gut wall over it. The reflected seromuscular rectangular flap is then brought down and sutured into position, thus burying the ureter in the lumen of the gut (Fig. 41, C).

IMPLANTATION OF URETER INTO SKIN: URETEROSTOMY

This is resorted to where the above methods cannot be employed, i. e., where the ureter is cut high, or where the technical difficulties are great. It is usually performed, if possible, in the lumbar region, this being the most direct route. It is never a satisfactory procedure on account of the great likelihood of infection and the extreme discomfort and annoyance to the patient. Many operators prefer to do a nephrostomy or nephrectomy instead.

Technic.—The proximal end of the ureter is clamped and brought out of the lumbar wound after ligating and cauterizing the distal end. The end of the ureter is then slit up from its cut end for 1/4 in. on opposite sides, and these ends are sutured to the skin. The ureter edge, at the angle caused by the slit, is sutured to the skin edge. There should be no sagging of the ureter, in order to prevent accumulation of urine. A catheter may be left in the ureter until union of the ureter to the skin wound is firm.

URETERECTOMY

Ureterectomy consists in the removal of the whole ureter (complete ureterectomy) or of a portion of it (partial ureterectomy). Ureterectomy may be done primarily, i. e., at the time the kidney is removed, or secondarily, i. e., at a subsequent operation.

Partial Ureterectomy.—Partial ureterectomy consists in the removal of a segment of ureter, followed by either an anastomosis, where the segment removed is not great, or an implantation into some viscus, where a considerable portion is removed. The ureter may be exposed either extra- or transperitoneally, the former being preferable. The ureter having been exposed and clamped above and below, the portion of ureter involved is removed, and an anastomosis between the divided ends performed if circumstances permit; otherwise, implantation is done, in which instance the lower segment is ligated, its end cauterized, and the proximal end sutured into either the bladder or large gut, according to one of the methods described under this heading.

Complete Ureterectomy.—This is done usually for tuberculosis, suppuration, or fistulous conditions of the ureter. It is commonly done concomitantly with removal of the corresponding diseased kidney, and is then spoken of as total nephro-ureterectomy, which will here be described.

TECHNIC.—The retroperitoneal route is, if possible, the one of choice, and the lumbo-iliac incision the one which will give the best exposure of the whole length of the ureter.

The incision having been made, the kidney is first exposed, freed from its bed, and its pedicle clamped and tied off, care being taken not to cut the ureter. The kidney is then pulled out of the wound, the ureter thereby being made taut and prominent. Retraction of the wound and the posterior peritoneum inward is next accomplished, and the ureter carefully separated along its entire length to the bladder, all bleeding being controlled as encountered. The ureter is now clamped and cut across as low down as possible, the distal end ligated, and its lumen cauterized, and the kidney and ureter are removed together. Drainage should be resorted to. The operation is an extensive one, tedious in its performance, requiring skill and extreme patience, and one which should be undertaken only when the exigencies of the case demand it in a patient who is able to withstand a prolonged operation.

[**Ureterectomy for Tuberculosis of the Kidney and Ureter.**—Not every case of tuberculosis of the kidney requires removal of the entire ureter. It is indeed at present a question among surgeons in just what cases nephrectomy should be accompanied by the removal of the ureter, but the present tendency seems rather to be that in the absence of severe shock or other contra-indication it is better to remove the tuberculous ureter along with the kidney. To be sure I have refrained from taking out the ureter in a large number of cases of nephrectomy for kidney tuberculosis and in my entire experience, extending over more years than I like to remember, I have been obliged to perform a secondary operation upon the ureter in only a very few cases.

Many of the cases of kidney tuberculosis and pyonephrosis are not in good enough condition to withstand a very serious surgical operation, and it will often happen that after a kidney has been removed the patient's condition is such that any further operative procedure would be unjustifiable. In such cases it is better to close the wound with drainage and after the patient has regained some strength and has improved in general health, to do a secondary operation and remove the ureter if such an operation be necessary.

If a sinus persists in the loin and takes on a tuberculous appearance or if on the other hand a pyo-ureter does not drain properly and becomes obstructed permanently or intermittently produces pain, fever and other local and general symptoms, it will be best to remove the ureter. In order to remove completely sufficiently and efficiently such ureters a liberal incision planned along the lines already indicated is best. Such a free exposure is necessary because a ureter so badly diseased that it requires removal is often, in tuberculous cases, greatly thickened and much larger than normal, and usually quite adherent to the surrounding tissues. It must be carefully dissected away from the posterior abdominal wall and from the peritoneum, partly by blunt dissection and partly by the use of the scissors. The ureter having been freed as near to the bladder as seems practicable it may be excised at the lowest accessible point and the stump treated much in the way that we treat the stump of the vermiform appendix. The stump if pliable may be surrounded by a purse-string suture, the interior cauterized with pure carbolic acid or the actual cautery and the suture tied after inversion.

If the wall of the ureter is much thickened and rigid, the stump may be cauterized and surrounded by a heavy catgut ligature. In either case it is safe and proper to drain the wound. For this purpose a cigarette drain or folded rubber dam answers the purpose well. In order to remove the ureter completely as close to the bladder as possible, Kelly of Baltimore has proposed to enter the lateral fornix of the vagina; to pull the stump of the ureter through the cut and there tie it off. In practice this procedure will rarely be found necessary.

Two other modifications of technic for removing the ureter have been proposed, one by Lillienthal, of New York, and one by Ransohoff. Lillienthal introduces from the kidney wound a bougie down the caliber of the ureter as near to the bladder as possible. This bougie is held in place by a ligature tied round the stump of the ureter. A small incision is then made internal to the anterior superior spine of the ilium. The muscles are divided, the peritoneum pushed away toward the median line and the ureter identified by palpation. The bougie is then removed, the ligature tied round the ureter stump and through the lower wound the ureter is pulled out and removed at the lowest accessible point. The plan suggested by Ransohoff is, after the removal of the kidney, to surround the stump of the ureter with the loop of a blunt uterine curet. While traction is made on the ureter the curet is pushed or insinuated downward, freeing the ureter, much in the same manner as one frees a varicose vein in the thigh, subcutaneously. The curet is then pushed up against the anterior abdominal wall and cut down upon. The ureter thus becomes accessible for ligation and removal.

Unfortunately when a ureter is so extensively diseased as to require removal it is usually so thickened, adherent and rigid that neither of these methods is easy or even practicable.—EDITOR.]

The prognosis of removal of the ureter depends to a great extent upon the general condition of the individual, the character of the lesion for which the kidney itself was removed, and the question of whether all the disease of whatever character can be treated surgically, and, lastly, by the after-care and ability of the individual to put himself under the most favorable hygienic surroundings. The operation for removal of the ureter, assuming that a previous nephrectomy has been performed, is not a very serious procedure in tuberculous cases. In cases of pyo-ureter when the ureter is thickened, adherent and greatly dilated, may be very difficult or even impracticable. In some cases the surgeon may be forced to drain the dilated pus sac and trust to time and local treatment to effect a cure.

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DIAGNOSTIC RÖNTGENOLOGY OF THE GENITO-URINARY TRACT

CHAPTER XIII

DIAGNOSTIC RÖNTGENOLOGY OF THE GENITO-URINARY TRACT

ARCHIBALD H. BUSBY

In the Röntgen examination of the genito-urinary tract the first thing to be taken into consideration is the fact that the shadows cast by the abdominal viscera vary but slightly in their density. Considerable care must be taken in the preparation of the patient as well as in the technic of the röntgen specialist in order to produce satisfactory röntgenograms that may be carefully studied so as to enable the physician making the examination to give a reliable diagnostic report.

Röntgenology is based upon the fact that the tissues of the body vary with the amount of resistance they offer to the passage of the rays and the degree of contrast by which an organ is shown in a röntgenogram varies according to the opacity of that organ to the rays as compared with the opacity of the tissues in which it is situated. The kidneys, for instance, are only slightly more resistant to the rays than the surrounding abdominal organs lying in the same path of the rays with the exception of the liver, which may at times tend to obscure the upper poles of the kidneys by its equal or greater resistance. If a kidney were placed within a thorax it would be clearly and easily seen by the contrast between the aerated lung and its own denser shadow. In their normal situation, however, they are only faintly seen because the surrounding structures are of very nearly the same density. A calculus within a kidney can be seen in the röntgenogram because the calculus offers still more resistance to the rays and consequently a less amount of ray penetration. This causes a diminished amount of chemical action in the röntgenogram with a resulting light or transparent spot which is superimposed on the kidney shadow.

Röntgenograms are much better for study than prints, and it must be kept in mind that shadows are shown by transparencies and not by densities which are the result of a large amount of rays penetrating freely. It can be readily understood that when a patient is not properly prepared, fecal masses can produce confusing transparencies in the röntgenogram which may obscure the kidneys or calculi, may cause large shadows which, when superimposed upon a kidney shadow, may be mistaken for a pathological condition of that organ or when a small, discreet intestinal concretion is in an anatomically suspicious situation it might be misinterpreted as a calculus. Another examination at a later date would clear up the diagnosis, but the delay, inconvenience and error should be avoided. Gas in the intestinal tract shows in the röntgenogram as a dense, more or less opaque shadow, and in some cases the whole colon may be demonstrated in this manner. Small fecal concretions when surrounded with gas can be very plainly seen.

The illustrations were drawn from prints of the röntgenograms, as this was found to be more satisfactory for reproduction. The transparencies mentioned above are therefore reversed and appear as densities or dark shadows of variable degree.

VALUE OF RÖNTGENOLOGICAL EXAMINATIONS

With the improvement which has been developed during recent years in the apparatus and technic, röntgenology is becoming more important negatively, and in many conditions such as oxaluria, phosphaturia, etc., which may present symptoms closely resembling those of renal calculus, röntgenology now gives most reliable information excluding calculus. On the other hand, a calculus may be large enough to disorganize a kidney without causing very definite symptoms of renal colic. This type of case may be considered an interstitial nephritis, but a calculus shadow in the röntgenogram would disclose the cause of the condition.

The early diagnosis of a renal calculus is always important as an undetected stone in the kidney may very readily be the cause of an interstitial nephritis. Intense renal colic is not usually caused by large calculi, but it is generally produced by small stones which create irritation by movement. The most acute cases are often those in which the small calculus is in transit within the ureter. The finding of a calculus does not always mean an operation, as the size, position, symptoms, and possibilities of expectant treatment may all be considered by the attending surgeon or physician, each case being decided upon its own merit. Röntgenology offers a valuable control in these cases by repeated examinations during the period that this treatment is carried out, and this may apply to cases of renal, ureteral, or vesical calculi of sufficiently small size to warrant the expectation.

A case of renal colic may have symptoms which are referable to the opposite side in which the calculus exists, and it is not uncommon to find a calculus in both kidneys while the symptoms only pointed to one side. Röntgenology is of value in cases where the symptoms are not marked. In such cases when a positive finding is reported, the danger of leaving an undetected calculus is removed and further destruction to the kidney avoided.

The negative röntgenological examination is now reliable enough to be of considerable assistance to consultants when exploration is being considered. In atypical cases of appendicitis it is considered important to rule out calculus. A report has been made from statistics recorded that prior to the introduction of röntgenology, the operation of nephrotomy for calculus was frequently undertaken without a calculus being found, in fact, in the hands of some operators the percentage of error was nearly 50 per cent. Röntgenology gives valuable aid when a case is to be operated as to the location, size, and number of calculi. When the examination is not of a recent date, other röntgenograms should be made just prior to the operation in order to be sure that the calculus has not moved.

Many writers in their conclusions have had no hesitancy in stating that röntgenology is the most valuable method at present in the diagnosis of calculi, and are of the opinion that it should be resorted to early so that in a positive case a patient may be saved the necessity of other methods of examination which may be painful or expensive. On the other hand, the Röntgen method often shows a reason why cystoscopy, catheterization of the ureters, injection of ureters and kidneys, or tests for tuberculosis should be made.

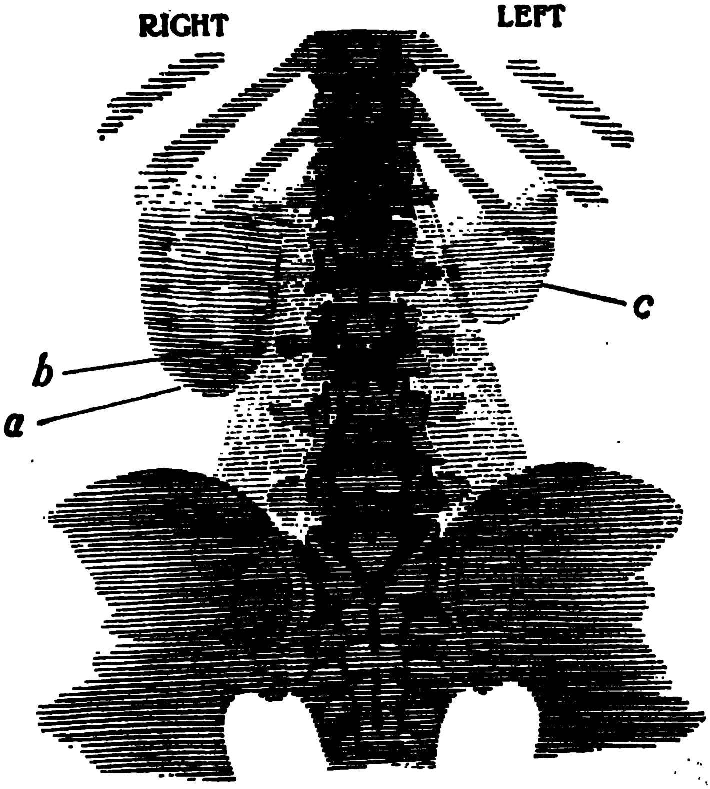

Fig. 1.—Tuberculosis of Right Kidney. (a) Enlarged right kidney. (b) Calcareous deposit. (c) Left kidney.

Morbid growths and diseased conditions of the kidneys are now frequently found and nephroptosis can be differentiated from other conditions.

APPARATUS

In the past röntgenologists have been hampered by the inefficiency of the apparatus. The static machine which required no outside source of electricity except as a convenience for the motor, while fairly efficient for light fluoroscopic work and röntgenograms of extremities and chest, was almost useless for heavy parts of the body which included röntgenoscopy of the genito-urinary tract.

The induction coils which were more generally used on a current of 110 volts, preferably direct, were more promising. These were run with the aid of an electrolytic or motor interrupter, and the improvements made from time to time greatly added to their efficiency. Their disadvantages were that they were not powerful enough to produce a sufficient amount of Röntgen rays necessary for short exposures. If quick work was attempted it was very hard on the tubes, the quality of the ray was much impaired by inverse current, and with heavy work the tubes could not maintain the proper quality of the ray for a sufficient length of time. Improvements in Röntgen tubes were made, especially when the tungsten targets were placed on the anodes, but these only partially removed the difficulties.

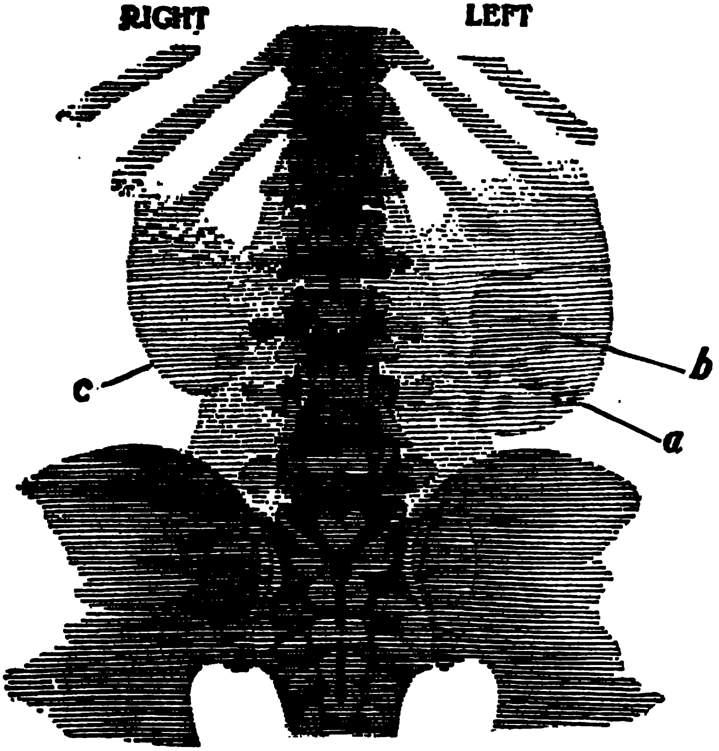

FIG. 2.—TUBERCULOSIS OF LEFT KIDNEY. (a) Enlarged left kidney. (b) Calcareous deposit. (c) Right kidney.

A great stride in progress was made by the introduction of the transformer or interrupterless machine. This apparatus can be made to run on a 110 or 220 volt alternating current and no interrupter is used. The inverse current, which was one portion of the difficulty in coil work, has in great part been removed by an apparatus called the commutator, which takes this inverse current, changes its direction, and places it at the proper poles in step with the rest of the high-tension current which passes through the tube. This commutator requires a motor which is run from the current supply, but the alternating current passes through the transformer without any interference. The transformer, which is the main portion of the interrupterless machine, produces a more powerful and improved quality of high-tension current up to 150,000 volts and as much as 150 milliampères. This produces in the tubes a more powerful ray with less inverse manifestations that enables exposures to be made in a much shorter length of time, i. e., a few seconds or even fractions of a second, while the tube maintains a radiation more or less unchanged during that exposure. If used with maximum currents, this machine is very hard on tubes. The interrupterless may be used on a 110 or 220 volt direct current by the use of an inverted rotary which generates an alternating current of reduced voltage which passes into the transformer without interference while the motor portion is used to rotate the commutator. The interrupterless can be used for instantaneous work. This has its obvious advantages when movements of the body are considered.

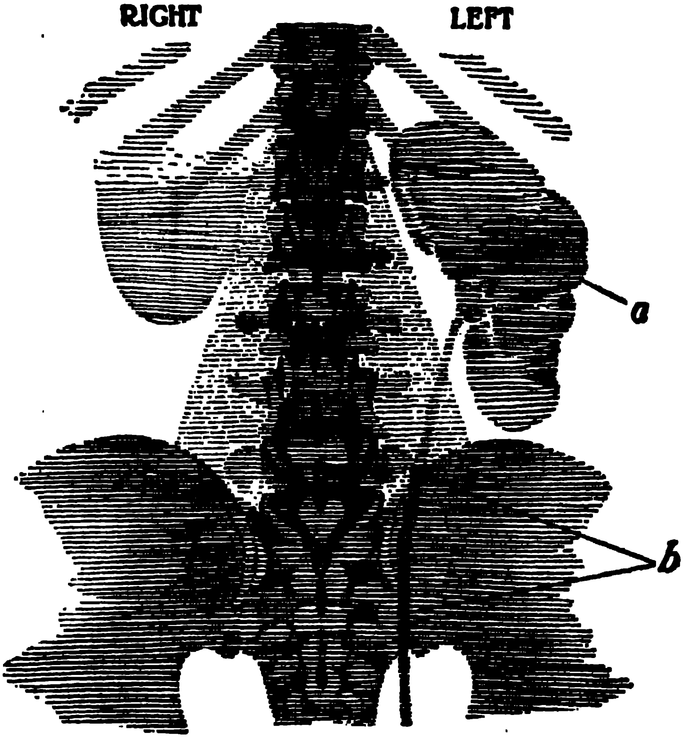

FIG. 3.—CALCAREOUS LEFT KIDNEY AND URETER. (a) Kidney. (b) Ureter.

A new tube which has been shown to be practicable is made with a glass bulb as usual, but is exhausted to an extremely high vacuum. The anode is composed of solid tungsten. The cathode, which is placed somewhat nearer than is usual to the anode, is composed of tungsten wire so coiled on itself as to form a small disk. This wire cathode disk is connected separately to a storage battery of about 10 volts, which is manipulated by the röntgenologist. The tube will not become radio-active with the high-tension current of a transformer until a large quantity of electrons (negatively charged ions) are heated out of the tungsten wire cathode. This is accomplished by the current of the storage battery properly regulated, passing through the cathode, causing the tungsten wire to become of such temperature as to drive a sufficient number of electrons from its substance and liberate them within the tube vacuum. When this condition has been obtained, which causes a very brilliant incandescence of the tungsten cathode, and which must continue during the operation of the tube, the tube becomes radio-active with the high-tension current of the transformer and it emits a Röntgen ray of extremely powerful character with definite and unvarying quality. The penetration can be changed with

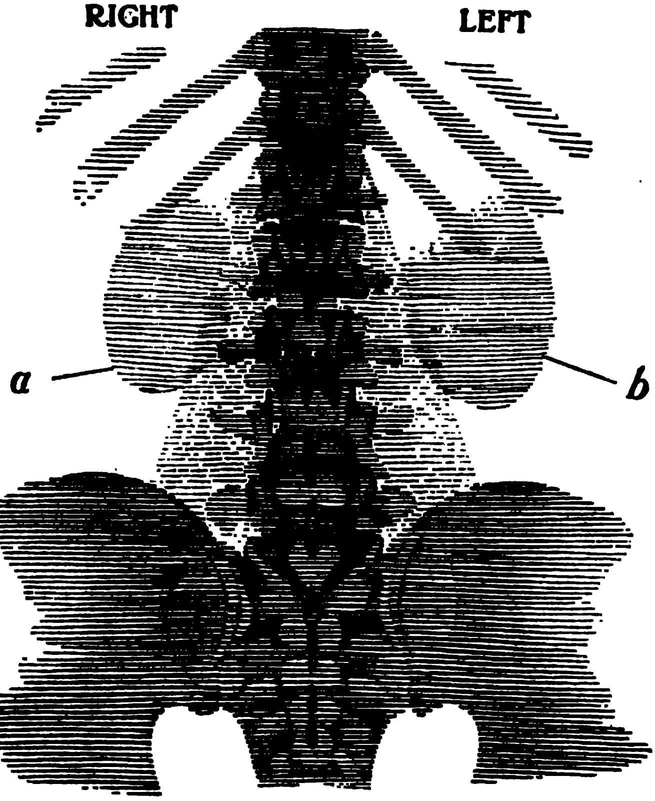

FIG. 4.—MODERATE NEPHROPTOSIS, DOUBLE. (a) Right kidney. (b) Left kidney.

a great degree of certainty by varying the high-tension voltage supplied by the transformer. To the observer there is no evidence of the Röntgen ray emanating from the tube as is seen by the fluorescence of the glass in the tubes now in use.

The advantages of the new tube are: (1) it is very powerful and permits shorter exposures; (2) known variations of the penetration can be made and controlled by the röntgenologist; (3) an unvarying quality of ray is created which may be maintained for long periods; (4) it is practically indestructible by the use of heavy currents and long exposures if the focus is broad. (More detail is created by the tube when it is made with a small or sharp focus.)

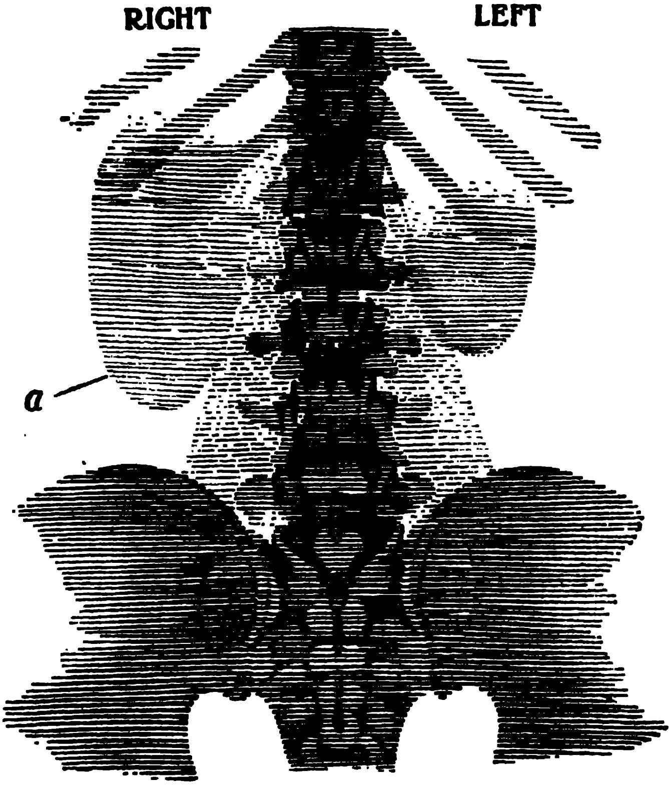

Fig. 5.—Pyelitis of Right Kidney. See (a).

Warning! This new tube should never be used except by röntgenologists who have been thoroughly instructed in regard to the dangers of the extremely powerful rays which it creates. Methods of treatment will have to be entirely reconstructed. Provision for greater protection of röntgenologists will have to be considered.

TECHNIC OF EXAMINATION

In the röntgenological examination of the genito-urinary tract the preparation of the patient is important, as the gastro-intestinal tract must be thoroughly cleansed in order to avoid errors and confusion. Attention given to preparation will, in many cases, prevent the delay and inconvenience of second examinations. At the same time it must be kept in mind that second examinations may often be necessary, even though the proper preparation has been made, in order to verify certain conditions found that are of a very delicate nature. This necessity can also be reduced by securing a large number of röntgenograms at the original examination, one to corroborate the other. Often a physician or surgeon will inquire about having a patient examined with the aid of only one röntgenogram. This is a condition which cannot be accepted by reputable röntgenologists, for the same results must be found in many röntgenograms in order that their interpretation may be reliable. A röntgenologist cannot allow himself to be hampered by specified limitations; any examination undertaken must be thoroughly covered. The details of technic are carefully considered by the physician making the examination, as he is respon-

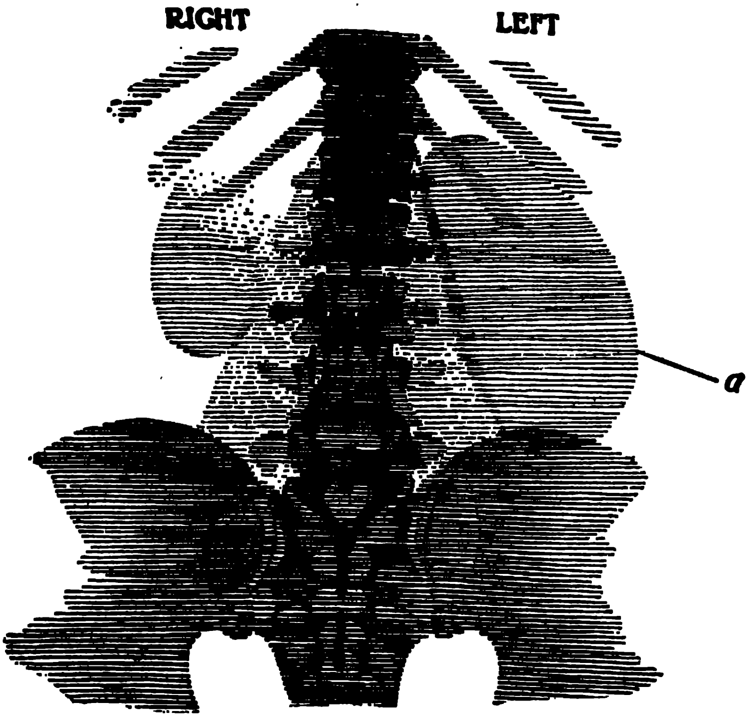

FIG. 6.—HYDRONEPHROSIS OF LEFT KIDNEY. See (a).

sible to the physician or surgeon attending the patient for a report which can be relied upon. Again, for example, the request to have a certain kidney examined may be made. This is impracticable, as the pain may be referred from some other part and a negative report in such a case would leave many conditions in doubt that should have been cleared up, or it may even lead to error. A calculus might have left the kidney, moved from one portion of the ureter to another, entered the bladder, or be located on the opposite side of the genitourinary tract. The same answer to both of these requests could be made, and that is, "the examination must be well done or not at all." *In every case both* kidneys, both ureters, and the bladder should be included with a generous overlapping of the röntgenograms.

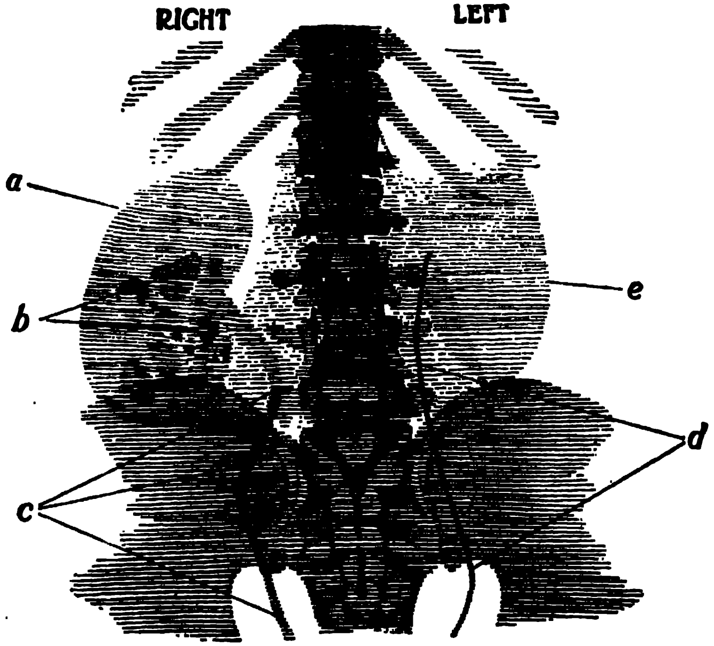

FIG. 7.—PYONEPHROSIS OF RIGHT KIDNEY. (a) Large, prolapsed and diseased kidney injected with collargol (b), showing loss of normal outline of pelvis. (c) Ureter shown with collargol. (d) Left ureter containing catheter. (e) Left kidney somewhat enlarged.

When all of the precautions mentioned have been observed, occasionally a second examination may still be necessary. In such cases it can be demonstrated to the attending physician or surgeon that it is advantageous to allow a time interval to elapse and to make another examination in order to verify the condition and prove that it is constant.

Concerning the preparation of the patient, it has been advised that abstinence from food be followed for 24 hours prior to the examination, but I have found fluid diet to answer as well. In either case an active purge must be taken not less than 8 hours before and an enema 1½ hours before examination. I have always made double röntgenograms with one exposure in order to obtain a sufficient number to insure results at a minimum amount of exposure of the patient.

The most careful technic with an efficient apparatus and accessories properly adjusted is essential for a satisfactory examination of the genito-urinary tract. The transformer must be powerful and able to produce an 8-inch lead pencil flame with the high-tension current used being about one-third of the full amount, and the commutator must be running in perfect step.

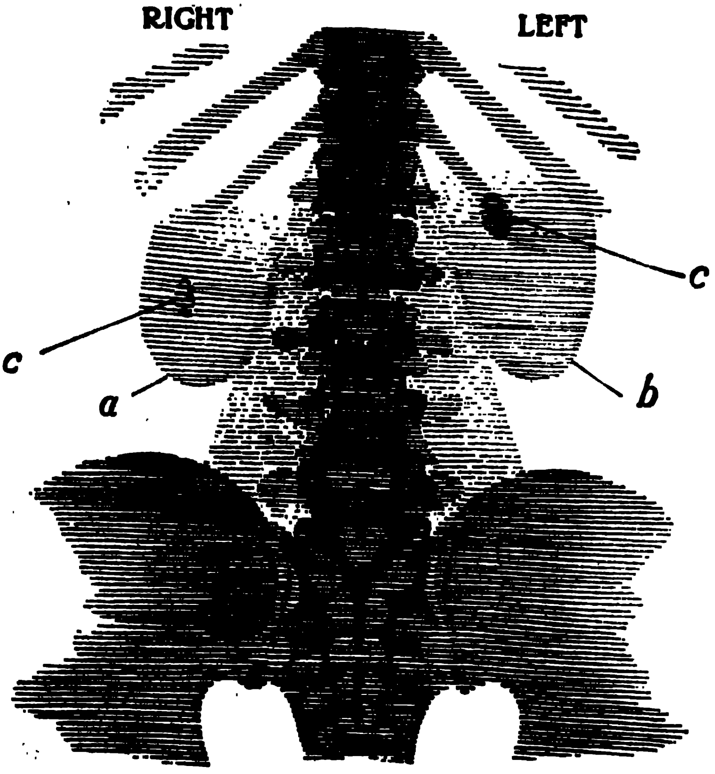

FIG. 8.—BILATERAL RENAL CALCULI. (a) Right kidney. (b) Left kidney. (c) Calculi.

The patient is placed upon the examination table in the supine position, and provision is made in the table for placing the plate under the back so as to be removed or changed without disturbing the patient. The thighs are flexed so as to allow the back to become straightened and rest on the table. The tube is placed above and not nearer than 11 inches from the skin, but often it is placed a considerable distance above. If necessary, exposures may be made without using a compression diaphragm, but compression has the advantages of preventing movement, reducing the amount of tissue which must be penetrated, and improving the detail of the röntgenogram. I prefer a compression cylinder of sufficient size to include both kidneys and the upper two-thirds of both ureters at one exposure. This will also include the bladder and the lower two-thirds of both ureters when placed in proper position. Smaller cylinders are used by some röntgenologists, but I prefer to use them for verification over certain limited areas. The matter of detail and contrast in the röntgenograms depends also upon the proper regulation of the tubes by which a ray of greater absorption is produced, in this manner causing more differentiation of tissues of nearly the same density. This is usually produced by a moderately low tube and a very heavy current. Some writers mention the difficulty of producing satisfactory röntgenograms in very stout patients. This is now generally believed to be more a matter of technic than size. Examinations may be made in the erect position for cases of suspected nephroptosis.

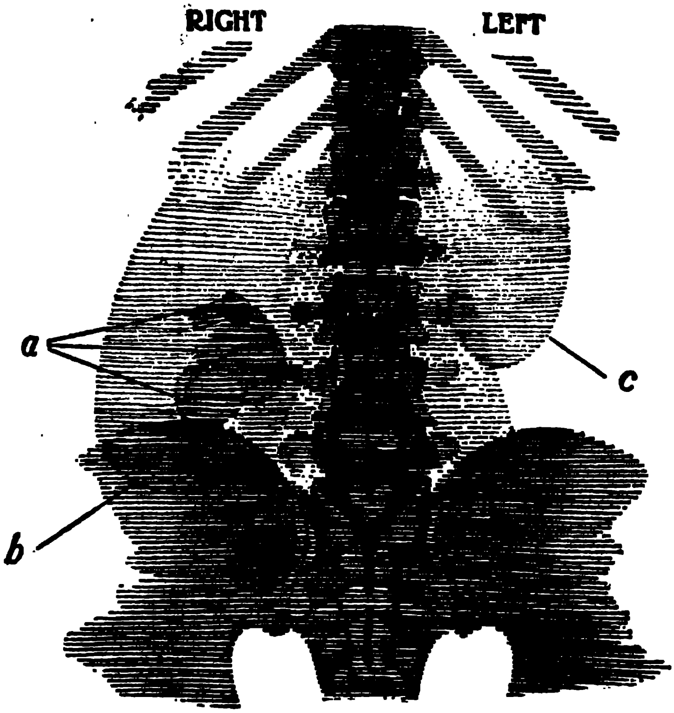

FIG. 9.—LARGE RIGHT RENAL CALCULI. (a) Calculi. (b) Outline of large diseased right kidney. (c) Left kidney.

The exposures last a few seconds or even fractions of a second and the patient must hold the breath for that time even with a compression diaphragm, as motion might easily obliterate the shadow of a very small calculus in the kidney. Some röntgenologists prefer a rather penetrating ray and a very short exposure, but one must be cautious as to the degree of penetration, as the rays from a tube too high can easily obliterate a slight shadow.

Röntgenograms are used in the examination of the genito-urinary tract, as the fluoroscope is entirely unreliable for a negative diagnosis.

Stereoscopic röntgenograms are made with the aid of an apparatus which is a part of most tables made for röntgenological purposes, that permits a shifting of the tube 1¼ inches to one side of the central point with a slight tilting of the tube toward the center and also 1¼ inches to the opposite side with the tube tilting again slightly toward the center, making in all a journey of 2½ inches. An exposure is made in each of these two positions and two separate röntgenograms are made without any movement on the part of the patient. The two röntgenograms are then placed in an illuminated apparatus which reflects the images by the aid of mirrors so as to superimpose one upon the other and create one impression which, when the apparatus is properly adjusted, will enable the observer to appreciate perspective or depth.

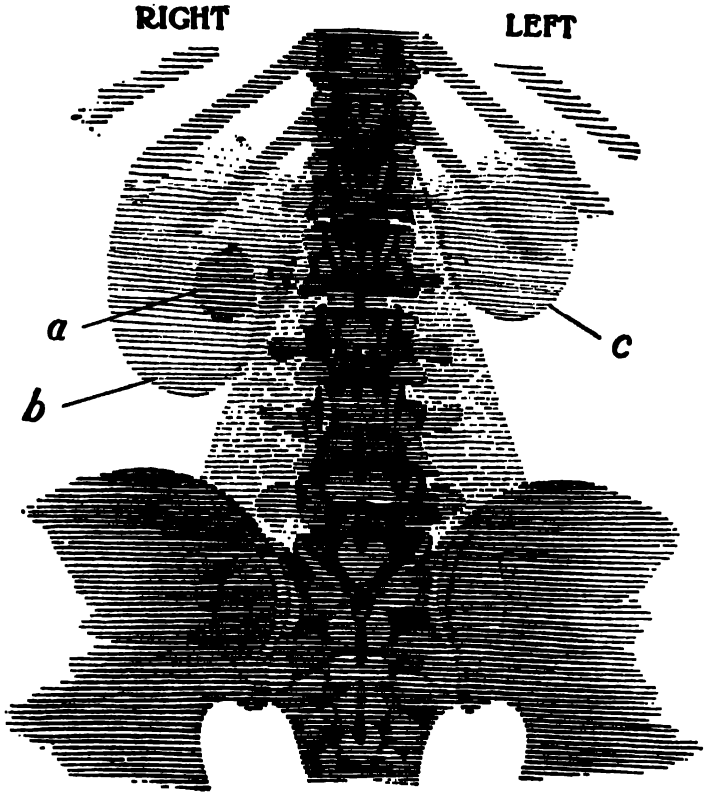

FIG. 10.—RIGHT RENAL CALCULUS. (a) Calculus. (b) Right kidney somewhat enlarged. (c) Left kidney.

Röntgenograms of the genito-urinary tract to be satisfactory should show clearly the vertebral column with its transverse processes, the two last ribs, the outer border of the psoas muscle, and, of course, the pelvic bones. If in addition the kidneys are visible, the röntgenogram is an excellent one for diagnostic purposes.

EXAMINATION OF THE KIDNEYS

In order to make the diagnosis reliable the röntgenogram must be as perfect as possible, and in a satisfactory one such as described above the negative diagnosis would be justifiable if properly interpreted. The positive diagnosis depends upon a shadow being evident within the outline of the kidney or within the region occupied by that organ. Figures 8, 9, 10, and 13 illustrate this point.

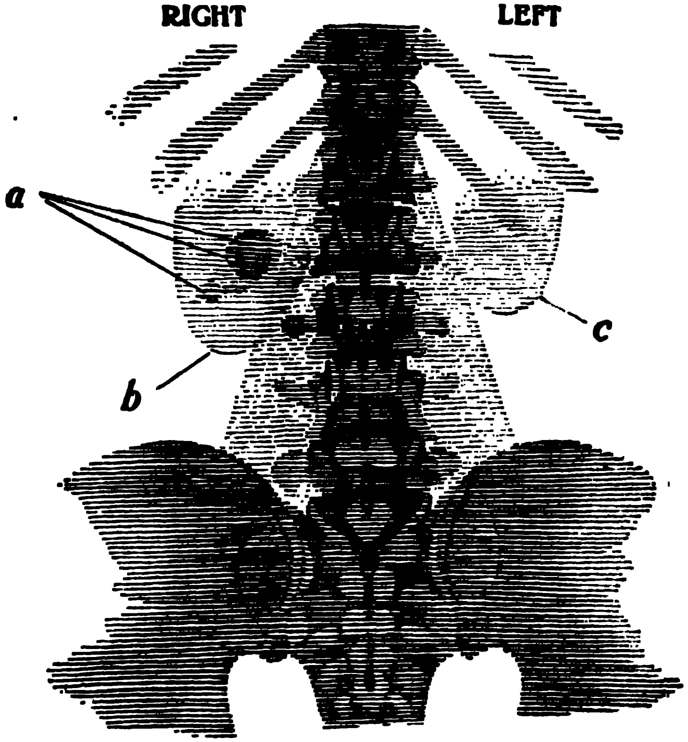

FIG. 11.—RIGHT RENAL CALCULI. (a) Calculi. (b) Right kidney shadow. (c) Left kidney shadow.

Calculi are composed mainly of calcium oxalate, uric acid, and phosphates of the alkaline earths. In addition to these main ingredients, cystin, indican, and xanthin may be found. The usual grouping of calculi by their composition is more or less artificial, as stones consisting of a single ingredient are comparatively rare and generally several ingredients are mixed in varying proportion. The terms used in designating certain types of calculi merely indicate that one or the other ingredient predominates. Uric acid and calcium oxalate calculi are by far the most common, but pure stones of either ingredient are unusual. The calcium oxalate calculi produce the strongest shadows. For instance, the pure uric acid calculus, which is quite rare, is very permeable to the Röntgen ray, but should it contain even 10 per cent. of calcium oxalate, the shadow in a röntgenogram should be quite plainly seen.

Carbonate of lime, phosphate of lime, cystin, xanthin, urate of ammonium, mixed urates, mixed phosphates, and ammoniomagnesian phosphate are rarely found as the nuclei or chief constituents of renal stones. Alternating calculi of uric acid, oxalate of lime, and the phosphates in distinct layers are not uncommon.

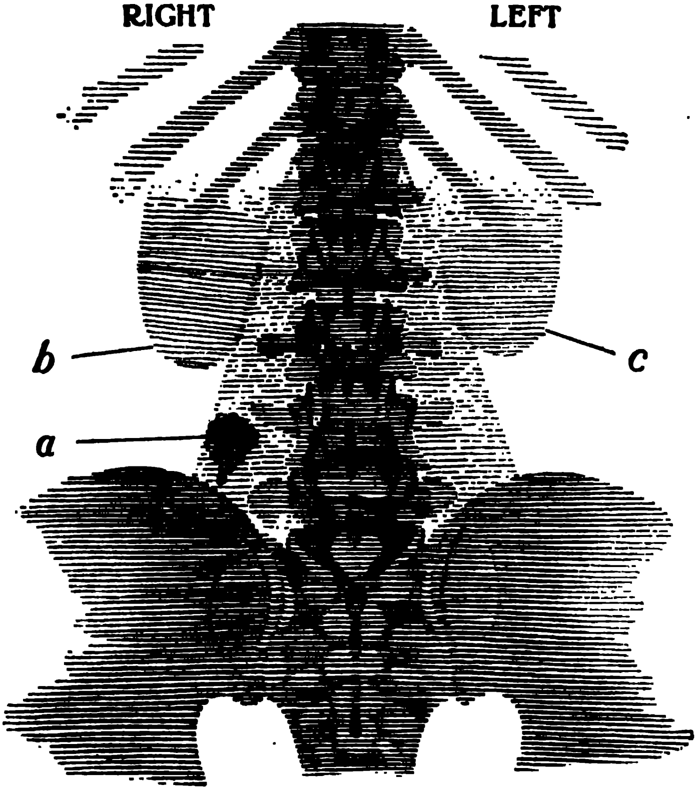

FIG. 12.—LARGE MULBERRY CALCULUS IN RIGHT URETER, 2ND POSITION. (a) Calculus. (b) Right kidney. (c) Left kidney.

Renal calculi may originate in the uriniferous tubes or in one of the calices of the kidney. They may be small, large, round, oval, irregular, smooth, rough, or a large branched mass filling all of the pelvis and calices. Of this last type, two have been reported weighing 3 and 5 pounds respectively. They may be small as a pin head or grape seed, weighing only a few grains, and still be detected in good röntgenograms. The frequency of calculi in right or left kidney is nearly equal, though some writers have reported it to be somewhat more frequent in the right. Calculi are found in all periods of life, and are reported to be as common in children as in adults, but in their passage down the ureter the child suffers much less pain than the adult. The calculi in children usually contain a large proportion of uric acid.

Positive diagnosis of renal calculus is in some cases quite simple (see Figs. 9, 10, 11, and 13), and need leave no doubt as to the correct interpretation of the röntgenograms. This is not general, however, for it is frequently necessary to give considerable study to certain cases. A calculus shadow does not always lie within the situation usually occupied by a kidney which is normal in size or position, for, in an enlarged, diseased or movable kidney, the position of the calculus may vary considerably. The shadow outline of the kidney is essential in such cases, and this requires great care and experience in the interpretation. In other cases when the kidney is more or less destroyed it is not always possible to detect an outline, but a mottled appearance with light and dark shadows may indicate the size and condition.

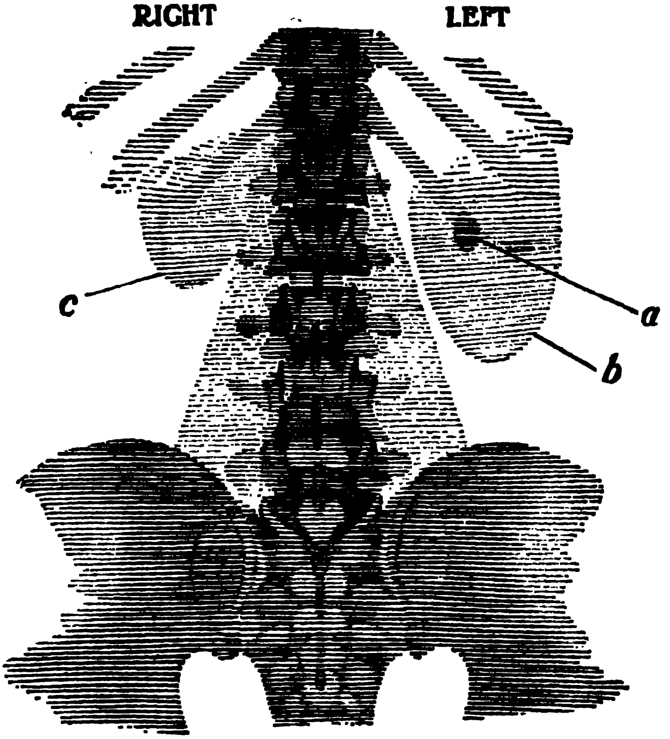

FIG. 13.—LEFT RENAL CALCULUS. (a) Calculus. (b) Enlarged left kidney. (c) Right kidney.

Objects other than calculi causing similar shadows within the outline of the kidney or in the position usually occupied by it often lead to confusion or difficulty unless care and perseverance are used. Of these objects may be mentioned calcareous mesenteric glands, biliary calculi, enteroliths, tubercular foci, or abscesses and foreign bodies in the alimentary canal such as undissolved iron or bismuth pills, shot swallowed with game, etc. Calcareous glands are a much more common source of difficulty, although a careful study of the röntgenograms will generally permit a differential diagnosis to be made. Considerable trouble may be experienced if the gland is solitary and not movable. Methods of differentiation in these cases will be mentioned under the examination of the ureters.

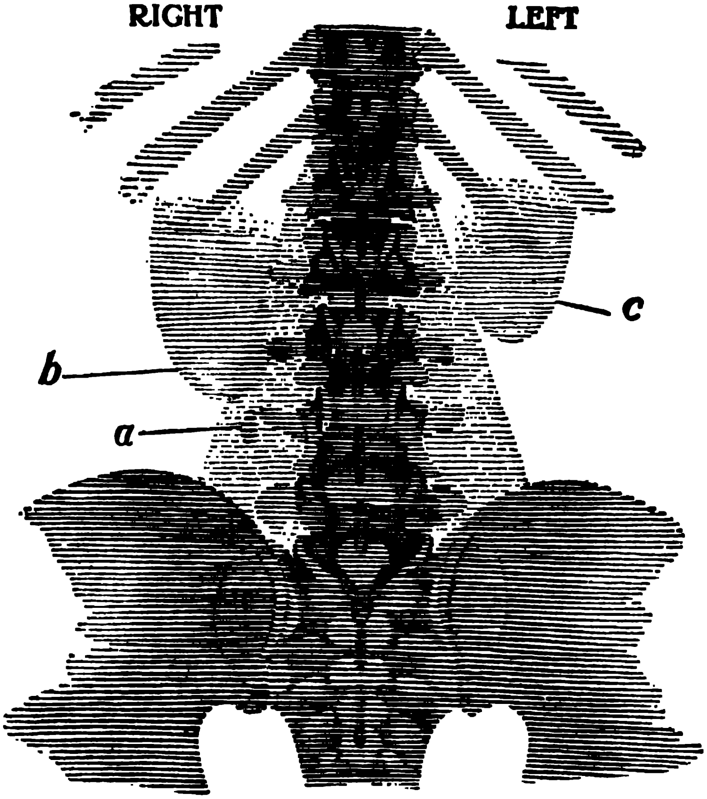

FIG. 14.—RIGHT URETERAL CALCULUS IN 1ST POSITION. (a) Calculus. (b) Enlarged right kidney. (c) Left kidney.

Röntgenological examination may throw considerable light upon the pathological conditions of the kidneys. Nephroptosis may be definitely diagnosed by an examination made in the supine, but preferably in the erect, position (see Fig. 4). Besides showing diseased kidneys containing a calculus, as already mentioned, röntgenology is often of value in demonstrating kidney changes such as cysts, tuberculous kidney, hypertrophy, atrophy, abscesses, pyonephrosis, hydronephrosis, and new growths. The clinical symptoms of some of these conditions may resemble those of renal calculus and, in some cases, after a negative examination has been made for calculus, the röntgenologist may be able to report an enlargement of one kidney as compared with the other. It is often very difficult to find the cause of the enlargement, but the finding in itself is of value, as the physician may avail himself of further analyses and methods of examination at his disposal with the object of clearing up this point. Renal cysts may show as faint dark shadows upon the röntgenogram, irregular but generally concentric or circular with an enlarged kidney shadow. A mottled appearance of the kidney substance with no reason to suspect a pyonephrosis is often a strong evidence of tuberculosis, especially if glands in the mesentery are observed. A tuberculous kidney may also show a slightly dense shadow of moderate or variable size with no definite outline usually in the lower portion of the kidney shadow (see Figs. 1 and 2). Hypertrophy is generally unilateral with the outline clear and sharp. Atrophy is more difficult, the substance may be slightly mottled, but the most usual cause is the existence of a calculus. Renal abscesses may resemble cysts, but are apt to be mottled, and analytical evidence

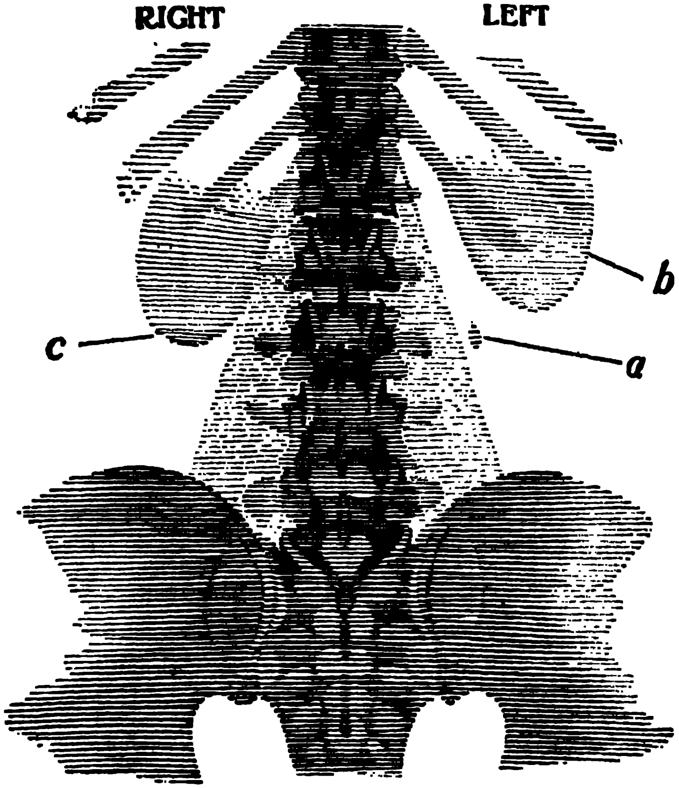

FIG. 15.—LEFT URETERAL CALCULUS, 1ST POSITION. (a) Calculus. (b) Enlarged left kidney. (c) Right kidney.

may be of material aid. Hydronephrosis (see Fig. 6) shows a large, clear kidney, while pyonephrosis is somewhat less clear, and a delicate shadow involving the pelvis may be observed. A renal tumor may show an asymmetrical enlargement of the kidney. In some cases of tumor there is a loss of the kidney outline, but an indefinite dense shadow larger than the kidney takes its place, while the outline of the opposite normal kidney can be seen. If the line of the psoas muscle on the affected side has disappeared the probability of tumor is increased. A distinct shadow of the lower pole of the kidney displaced downward, while the upper portion and the psoas muscle are obliterated, is also suspicious. In these cases the physical examination, clinical and analytical data must be carefully considered with the röntgenological findings. Collargol injections, besides showing malposition of the kidneys (see Fig. 18), may demonstrate certain diseased conditions, enlargements (see Fig. 7), and congenital abnormalities of the kidneys and ureters.

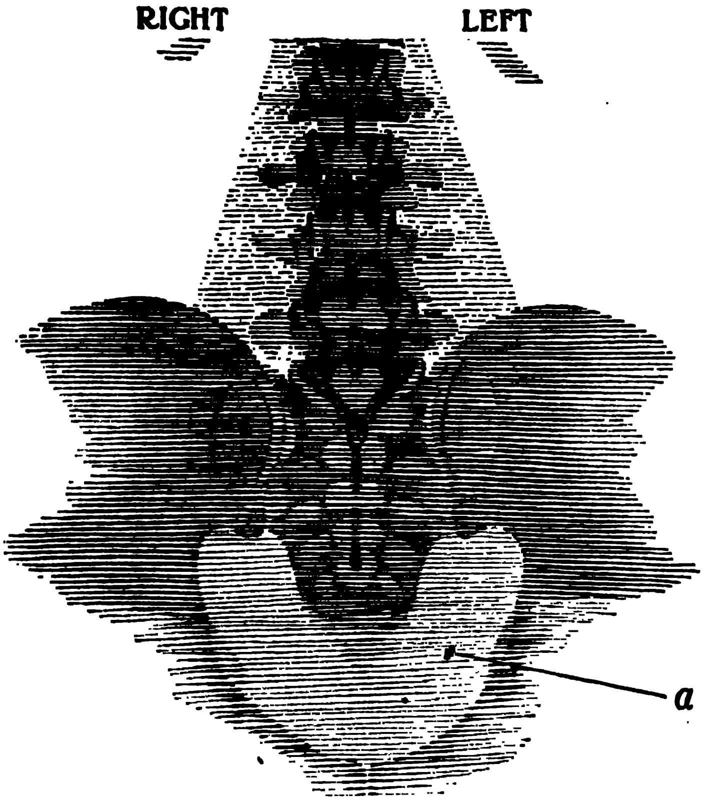

FIG. 16.—LEFT URETERAL CALCULUS, 3RD POSITION. (a) Calculus.

EXAMINATION OF THE URETERS

For the diagnosis of ureteral calculi röntgenograms must possess the good quality already described, as the shadows of the kidneys are essential to permit differentiation, and the calculus shadow must naturally appear within the course of the ureter (Figs. 12, 15, and 16). In this regard caution must be exercised, as in stout patients the course of the ureters may be slightly further from the median line than in thin subjects when the tube is placed over the center of the body and both ureters are included in one röntgenogram. In stout patients the ureters are further away from the röntgenogram, and spreading, due to the divergence of the rays, is the result unless the tube is placed at a considerable distance from the body. Ureteral calculi, on account of migration, are as a rule more painful, and therefore are sent more frequently to röntgenologists. Left ureteral calculi are found in greater proportion than right.

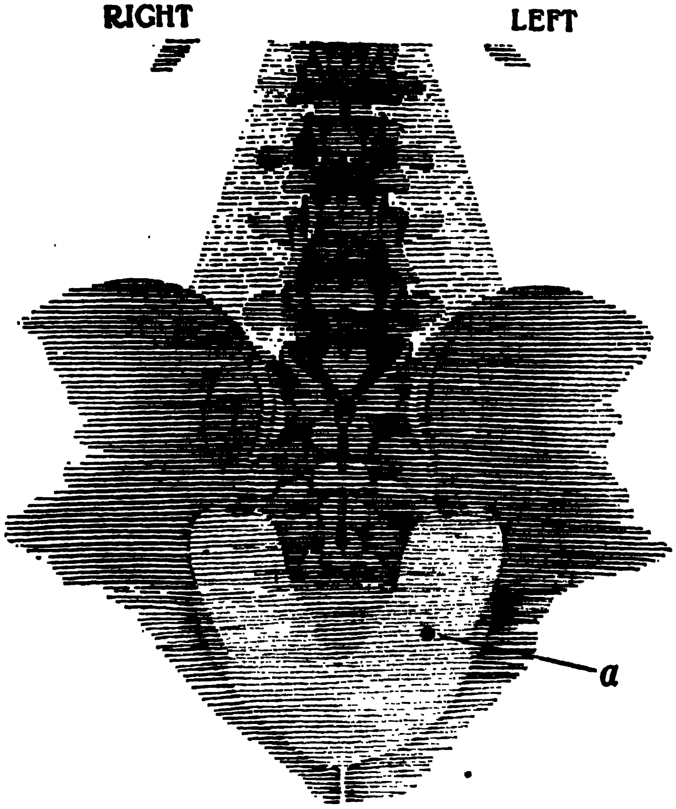

Fig. 17.—Foreign Body (Shot) in Gastro-intestinal Tract from Eating Game. Similar to calculus but ruled out by differentiation and second examination. (a) Shot.

The calculi are usually small, but when they are impacted may attain considerable size; they have been found 2 inches in length. They are generally oval or elongated in shape, but may be round, irregular, angular, or pointed.

For location of a calculus the ureter may be divided into three parts. The first situation is about 7 cm. down, where the ureter has a diameter of about 3.2 mm.; the second is just above or below the brim of the pelvis, and here the diameter is about 4 mm., the third point is just above the entrance to the bladder, this being the narrowest portion and the diameter being about 2½ mm.

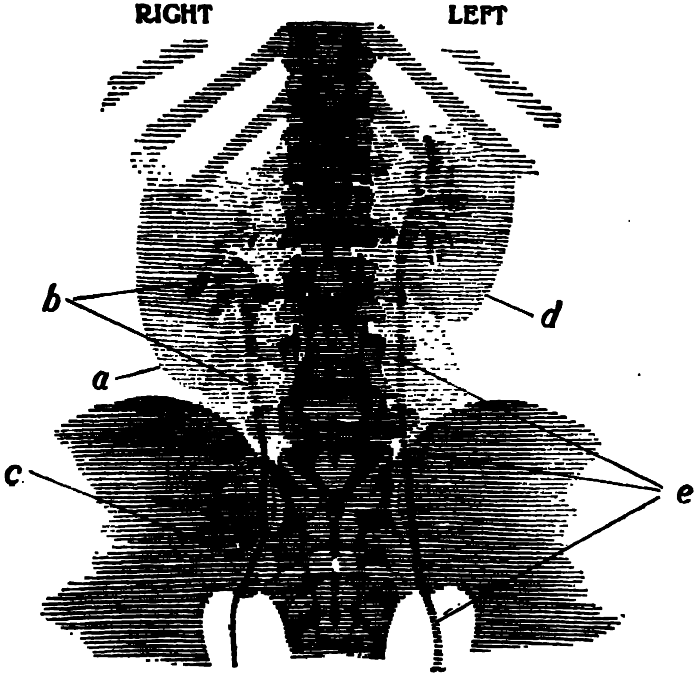

FIG. 18.—NEPHROPTOSIS, RIGHT, WITH COLLARGOL INJECTION IN BOTH KIDNEYS. (a) Ptosic right kidney. (b) Collargol in pelvis of right kidney and upper part of ureter. (c) Catheter in lower part of right ureter. (d) Left kidney with collargol in pelvis. (e) Collargol in left ureter.

The frequency at these points for lodgment of calculi has been roughly estimated for the first location at 29 per cent., the second at 14 per cent., and the third 57 per cent.

Among the various bodies that may be mistaken for calculi are the phleboliths so often present in the pelvic veins of women especially, cheesy and chalky masses in old inflammatory exudates particularly in the broad ligaments, calcareous mesenteric and pelvic glands, atheromatous plaques in blood-vessels, small calcareous bodies in the ends of the Fallopian tubes and in the ovaries, concretions in the appendix, ossification spots in the pelvic ligaments, and concretions or foreign bodies in the gastro-intestinal tract. The situation of these objects will help materially in making the diagnosis, but if the shadow appears in the course of the ureter, great difficulty is often experienced. Calcareous glands are frequently a source of trouble, but in the majority of cases they are movable or multiple, so the number and distribution may aid in making the diagnosis clear (see Fig. 22). When there is only one gland in a suspicious position, it may be necessary to catheterize the ureter, using a catheter which is opaque to the Röntgen ray or collargol injection in order to decide the diagnosis with the second set of röntgenograms. A calcareous gland is usually hazy in outline, of uneven density, and spheroidal in shape. A calculus is more apt to be clear in outline, of uniform density, more constant in position and oval, pointed, or rectangular in shape. Foreign bodies in the alimentary canal can be eliminated by purging and making a second examination. The outline of the kidney, when seen not to be related to the calculus shadow, will remove the possibility of a calculus being located in an enlarged or displaced kidney. When a doubtful shadow lies within the course of a ureter the Röntgen bougie or catheter is generally preferred to the injection method, as obstruction may be appreciated at the site in question or, if it passes by a small calculus, the nodule or bud may appear on the side of the catheter, and the instrument causes little if any distortion to the normal course of the ureter. Should the catheter and shadow in question be unrelated, the calculus can be ruled out. This method is

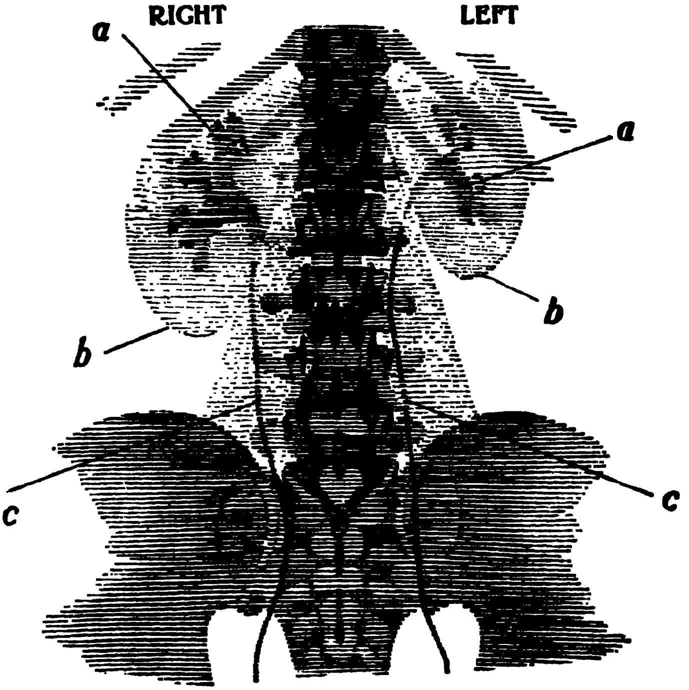

FIG. 19.—COLLARGOL IN BOTH KIDNEYS AND CATHETERS IN BOTH URETERS. (a) Collargol in pelves of kidneys, right kidney enlarged. (b) Kidney shadows. (c) Catheters.

also used to determine whether a calculus is in the third location of the ureter or the bladder when any doubt exists.

EXAMINATION OF THE KIDNEYS AND URETERS BY MEANS OF INJECTION

This method of examination is accomplished with the aid of colloid silver solutions, which are relatively opaque to the Röntgen ray and produce shadows of the ureters and pelves of the kidneys upon a röntgenogram. The patient must be injected by a cystoscopist who has had experience with the method of procedure, as the operation is not without its dangers and failures. These cases placed in the supine position should be injected upon the röntgenological table and the examination should be made immediately after the injection without disturbing the patient in the slightest degree. The technic and pressure necessary to inject the solution lie naturally within the province of the cystoscopist. Argyrol, collargol, or cargentos may be used, but collargol in 10 to 15 per cent. strength seems to be more generally favored, and this gives a very satisfactory

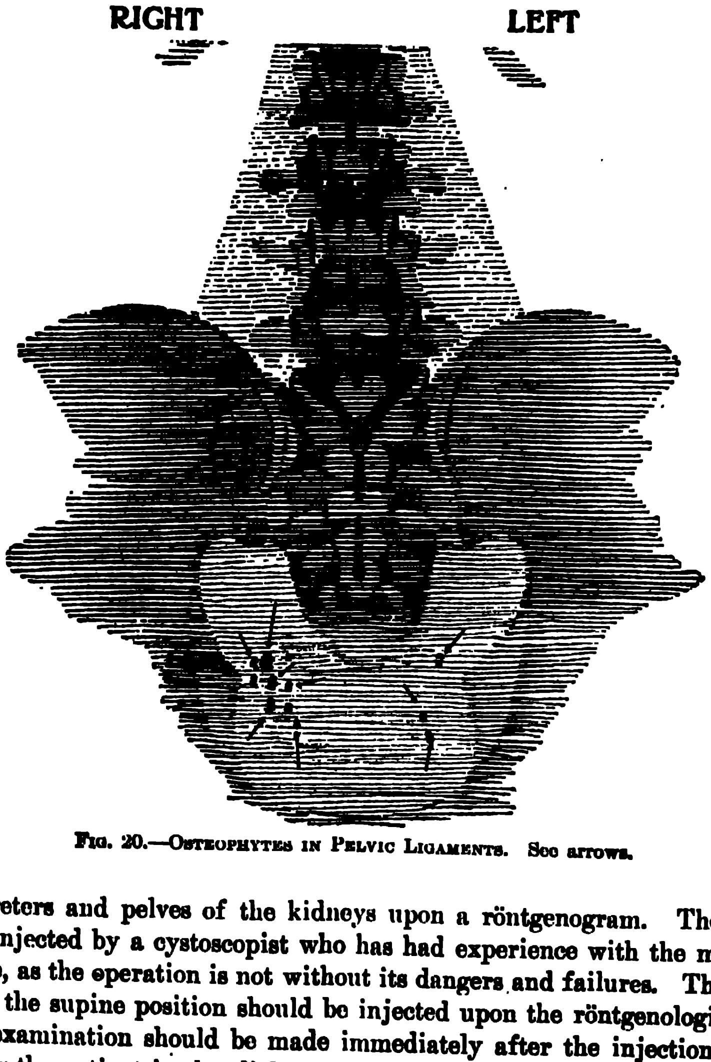

FIG. 20.—OSTEOPHYTES IN PELVIC LIGAMENTS. See arrows.

shadow in the röntgenogram. Injections which give the true position of the ureters have proved that the catheters when inserted do not cause much distortion, if any. (Compare Figs. 18 and 19.) The injected pelvis gives information relatively as to the size and position of the kidney, also as to the size and shape of the pelvis. A diseased kidney may be recognized by the irregular and scattered distribution of the solution with a loss of the normal outline of the pelvis (see Fig. 7). Nephroptosis can be very perfectly demonstrated, and it is preferable to make an examination in the erect position after the supine has been finished (see Fig. 18). Congenital malformations of the kidneys and ureters may be diagnosed, also dilatation or kinks in the ureters and the position of the ureters for differential purposes.

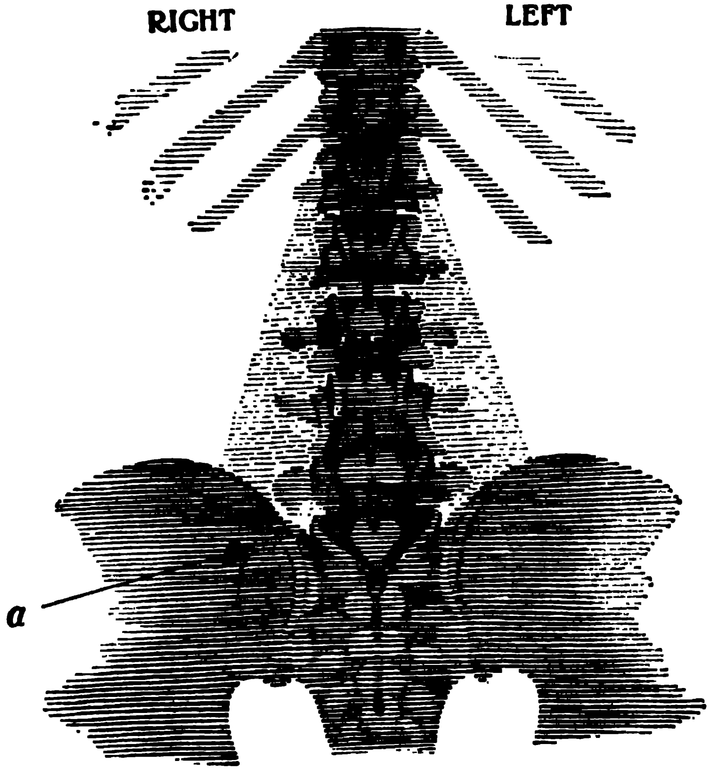

Fig. 21.—Calcareous Formation Around Silk after Appendectomy. See (a).

Pyelography aids in the diagnosis of many cases, but it must not be lightly considered, as its use is not without a certain amount of danger, but this can be greatly reduced by an experienced and careful cystoscopist. It has been claimed that the parenchyma of the kidney may be invaded with undue pressure even to the capsule, and that it may infiltrate the lymphatic vessels, thus giving rise to a secondary necrosis of tissue. It is considered hazardous to inject a tuberculous kidney, as it may cause distribution of the disease into healthy tissue. Two or three cases of collargol poisoning have been reported.

EXAMINATION OF THE BLADDER

The röntgenogram must include the whole of the bladder and the lower portions of the ureters. Smaller diaphragms may be used over a doubtful or suspicious area to secure additional detail. Vesical calculi are common to all ages. In one set of 21 operative cases reported in children, 18 were under 15 years of age and the majority were under 8 years (Werther). Röntgenology is essentially the first method of examination for vesical calculi, as it entails no inconvenience or suffering of the patient. It gives reliable positive evidence and may serve the purpose of diagnosis unaided. With the improved technic errors are far less frequent. Caution should be exercised with negative diagnoses for the pure uric acid calculi are more frequently found in the bladder, where they may originate, and they often form the nuclei of vesical calculi, although they rarely increase to a large size without combination with other more opaque

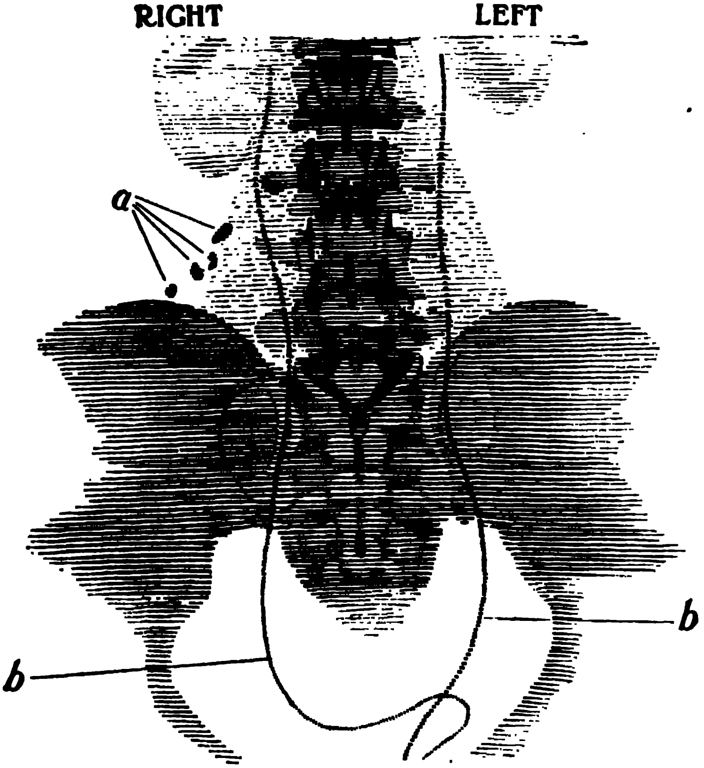

FIG. 22.—CALCAREOUS MESENTERIC GLANDS. (a) Glands. (b) Catheters.

ingredients. Vesical calculi may also originate in the kidney. When this occurs, they pass as small stones through the ureter to the bladder and become the nuclei of bladder stones. Chemically, vesical calculi resemble for the most part those found in the kidney. The calculi rarely consist of any one material, but of several ingredients commonly arranged in successive layers, one layer occasionally being of one ingredient. They may be of flattened ovoid or spherical shape, but generally smooth (see Fig. 24). Occasionally irregular forms, due to fixation or diverticula, are found. They may increase to a very large size, but are rarely found weighing more than 6 or 7 ounces.

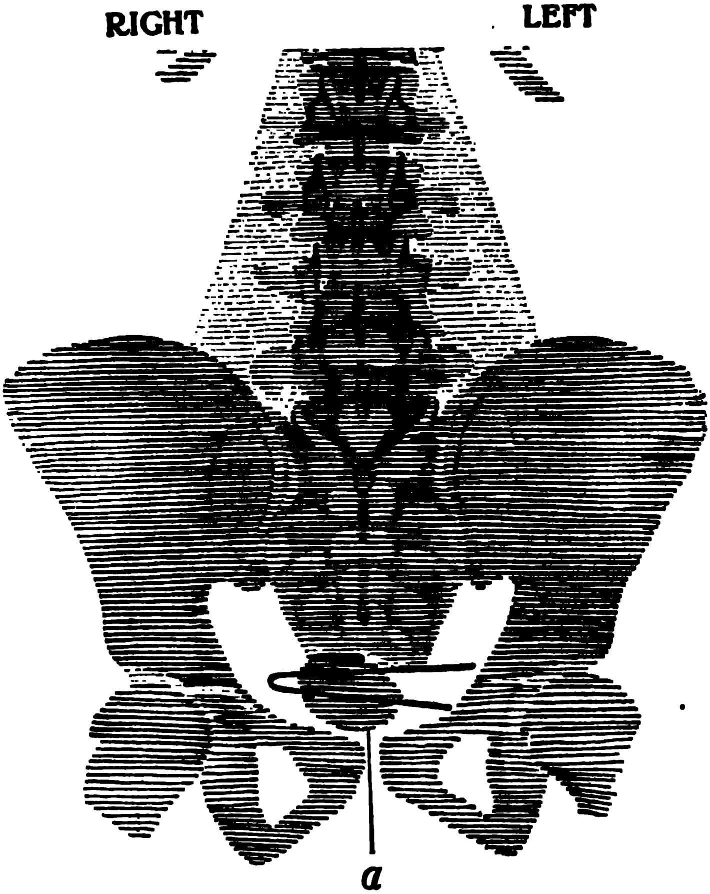

FIG. 23.—HAIR PIN IN BLADDER WITH CALCULUS FORMED UPON IT. (a) Calculus.

Conditions which may by their shadows cause confusion in addition to those mentioned under the examination of the ureters are calcification in a tuberculous bladder, in the vasa deferentia, and prostatic calculus. "Pelvic blotches" is a term a little too general in its significance, as almost any of the entire list may be so called. The term as used is usually meant to indicate calcareous deposits of various sizes that occur in the ligaments of the pelvis (see Fig. 20). These shadows are usually spherical in shape, never irregularly angular, and the outline appears clear and sharp. In the majority of cases they are quickly recognized by the situation being just too far out to be in either the ureter or bladder, by being multiple, and many times by being in close proximity to the spine of the ischium. If the shadow should lie over the course of the ureter or within the area of the bladder, the diagnosis may be far from easy and cystoscopy may have to be resorted to. Tilting of the pelvis from above down during the examination or turning the body slightly upon the side may cause a change in the position of a vesical calculus, and sometimes in a second examination the calculus may show a change in regard to the situation as compared with that in the former röntgenogram. Difficulty is experienced in cases of questionable calculi by their being encysted or in a fixed position. In such cases cystoscopy is a great aid, but the result of using a stone sound cannot always be relied upon. Foreign bodies in the bladder such as safety-pins, hair pins, etc., are readily recognized in the röntgenograms. When they have re-

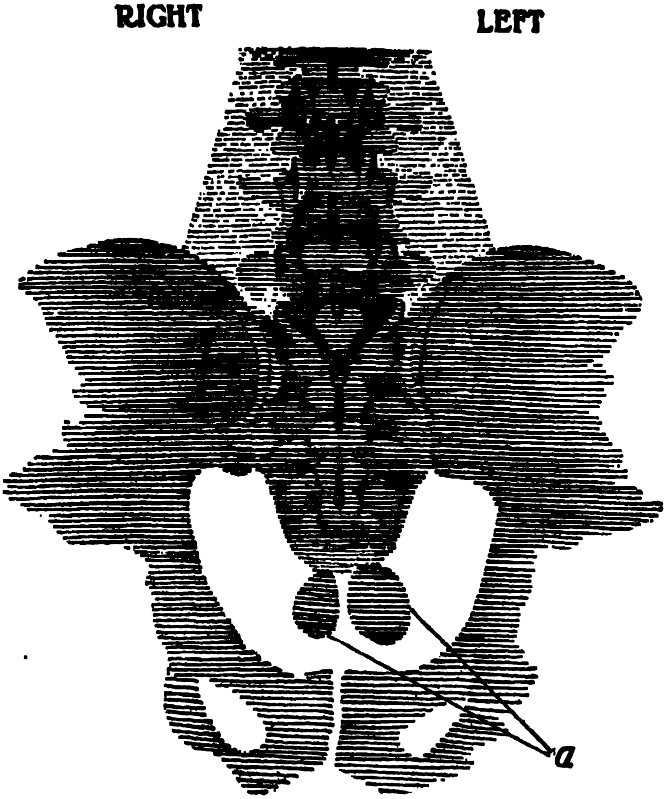

FIG. 24.—VESICAL CALCULI. See (a).

mained in the bladder for a considerable length of time a calculus may be found upon or around them (see Fig. 23).

Efforts have been made to accentuate the shadows of small vesical calculi composed of little else than uric acid and urates by inflating the bladder with air or oxygen with the Drager-Wollenberg apparatus. This has fallen into disuse of late because it is a procedure not free from danger, as deaths have occurred from air embolism (Cohn).

Pathological conditions of the bladder are obviously within the province of the cystoscopist.

Prostatic calculi may be considered with bladder examinations on account of their intimate relation. These are located a little further down in the röntgenograms than the bladder. They may originate from concretions in the prostatic ducts or from ordinary calculi that become impacted in the prostatic portion of the urethra. The continued growth by deposition of phosphates may cause such stones to become firmly fixed. Prostatic calculi originating in the prostatic ducts are quite common in elderly men and are rarely larger than the size of a pea. They usually contain enough phosphates to cast a definite shadow and may be single or multiple. Ravasini reported a prostatic calculus weighing 10 ounces and measuring 4 x 3 x ½ inches in its greatest dimensions.

INTERPRETATION OF RÖNTGENOGRAMS

Röntgenograms of satisfactory quality must be obtained, and it is necessary that the röntgenologist making the examination should have had considerable experience in order to render a reliable and accurate report. The differential characteristics of bodies other than calculi, such as phleboliths, osteophytes, calcareous glands, etc., which produce shadows, are mentioned in the examinations of the specified regions. Many of these shadows are readily understood when they display the various differential qualities. It is in the difficult borderline cases that great care must be exercised in order to pursue the proper course for future examinations so that accurate conclusions may be reached. One must be able to appreciate shadows in a röntgenogram that would ordinarily pass unobserved, but the conscientious röntgenologist will not allow the history to influence him to the slightest degree other than as a general guide until after he has thoroughly studied the röntgenograms. It is necessary that the röntgenologist be instructed by the attending practitioner as to the nature of the examination desired and the various points which he wishes to have cleared up, as the technic depends upon the nature of the case to be examined. Before the final summing up of a case it is essential that the röntgenological report be considered carefully with all of the clinical and analytical data available. The responsibility assumed by the röntgenologist is no small matter, and conservatism must be an important factor in the interpretation. Careful study of the röntgenograms must be made from every point of view, as the result may show a different condition than was originally suspected. If so, a consultation with the attending physician or surgeon is necessary, and the advisability of studying the case with the röntgenological findings must be considered. The symptoms of many abdominal conditions may be atypical, for it is not uncommon in a case of suspected calculus to find a diseased kidney, a calculus of the opposite side, or a sacro-iliac lesion, and this would naturally suggest further investigation. In regard to calculi, except in very rare cases due to a pure uric acid stone, it should always be possible to arrive at a definite diagnosis, yet röntgenology is not infallible. It may be justly claimed that with the best technic the errors do not exceed 1 per cent., and are therefore fewer than with any other method of examination.

Relation of the Röntgenologist to the Physician and Patient.—Röntgenological examination must not be made unless advised by the physician attending the case. If the patient has no physician, one must be secured and examination advised before it can be made. Information desired by the röntgenologist should be obtained from, and the report of the examination must be made only to, the attending physician. The röntgenologist never expresses an opinion or gives advice to the patient. It is justly due the physician who sends the case for examination, that the röntgenograms be demonstrated to him and a consultation may be necessary before the case is completed. The patient is in no way concerned with the röntgenograms or prints, as this is purely a medical examination and the röntgenograms are only a part of the means by which the result is accomplished. The röntgenograms are filed away and may be used for future reference in regard to the case when requested by the attending physician. Prints may be supplied to the physician sending the case for examination in order to make his records complete.

The present situation in röntgenology may be covered by the opinions of different writers that:

(1) It adds a certainty to the diagnosis of renal calculus hitherto unobtainable and thus differentiates not only calculus disease from other affections of the kidney, but also from diseases of other abdominal organs and bones, giving rise to pain, such as spinal caries, female pelvic ailments, gall-bladder affections, appendicitis, sacro-iliac disease, etc.

(2) It often makes possible an early diagnosis where the symptoms are slight and allows an operation to be performed at a period when the outlook is far more favorable owing to the absence of any septic complications or any extensive destruction of the kidney.

(3) It prevents an undetected calculus from remaining in the kidney for a long time and causing an interstitial nephritis.

(4) It may show the calculus to be on the opposite side to that to which the symptoms are referable.

(5) A calculus may be found in both kidneys when the symptoms are on one side only.

(6) Migration of a calculus may be shown by examinations made at time intervals.

(7) It gives material aid in showing the size, shape, number, and location of calculi when an operation is contemplated.

(8) It is important to secure as much information in regard to both kidneys as possible before operation.

Complete examination of both kidneys, both ureters, and the bladder should be made in every case. It may be as well to bear in mind that a röntgenological examination does not consist merely of the production of a röntgenogram, which, it is assumed, will give all information in regard to a case. In some cases it may be used to verify some point of an examination either negatively or affirmatively, and therefore may be only a part of the whole examination where the röntgenological report must be considered with all of the clinical and analytical data.

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OPERATIONS UPON THE PROSTATE GLAND

CHAPTER XIV

OPERATIONS UPON THE PROSTATE GLAND

J. Bentley Squier

Indications.—Three pathologic conditions produce the main indications for operation upon the prostate gland, which, in order of their frequency of occurrence, are: benign degenerative changes causing a disturbance in the act of urination, suppuration within the organ, and malignant growth.

The indications for operation in suppurative processes within the prostate it is unnecessary to discuss, as it is an axiom of surgery to evacuate pus wherever found; and experience has proved beyond doubt that spontaneous rupture of an abscess of the prostate is fraught with complications rarely to be encountered after surgical drainage.

On the other hand, indications for operation upon the prostate when benign or malignant degenerative changes have taken place are still open to some discussion. Happily, however, recent improvement in operative technic upon the prostate and the knowledge of the importance of preparatory treatment of the patient have removed many of the operative dangers.

Considering the question of indication for operation in benign hypertrophy of the prostate causing obstruction to urination, one indication is self-evident, namely, relief of the obstruction. The question at once resolves itself into an operative or non-operative solution—either catheter life or some form of surgical maneuver to overcome the obstruction.

A point to be taken into consideration, and one not generally sufficiently well appreciated, is that, from a collection of reliable data, the percentage of mortality due to catheter life exceeds that of prostatectomy at the hands of competent operators.

In order to add testimony to the aforementioned statement, the vital statistics of a series of patients suffering from varying degrees of prostatic obstruction who were not subjected to operation, as well as those of the operative cases, are here given.

The cases selected for study were those who had been under my care during the past 4 years and whose histories I have been able to follow up to the time of death or to the present. Thirty patients suffered from benign hypertrophy and 5 from malignant disease. Seventeen were upon catheter life, using the catheter only during the attacks of acute retention, once or twice a day to relieve overdistention, or depending entirely upon the catheter. Of these 17, 14 have died, with an average duration of life of 2 years and 10 months after commencing catheter life.

Included in the list is one exception, namely, a patient who had lived 15 years after beginning the use of the catheter and died of an intercurrent disease, pneumonia. Death in 12 cases was directly traceable to a suppurative renal lesion, nephritis plus sepsis. One died of apoplexy. Three are living, 2 at the end of 1 year and 1 at the end of 5 years.

Of the patients not upon catheter life, the mortality during the same period of observation as with the others has shown a great difference.

Fifty per cent. are living, and of the 50 per cent. who have died, the average length of life after the onset of obstructive symptoms has been 4 years and 8 months.

If any conclusion could be drawn from these cases, it would be summed up about as follows:

Fifty per cent. of unoperated patients will die within 5 years from the onset of obstructive symptoms where catheter life is not necessary. The beginning of catheter life shortens this expectation of life almost 50 per cent. (2 years and 8 months), and increases the mortality to 66 2/3 per cent. within the shortened period.

As the question of percentage of mortality between operative and non-operative treatment of prostatic obstruction can be definitely decided in favor of operation, it only remains to decide which operative procedure is most applicable to the individual case and at which stage of the disease's progress operation is best indicated.

During the first stage of urinary obstruction due to prostatic hypertrophy, the symptoms resemble those of urethral stricture, a slowness in starting the flow of urine, a tendency to urinate in instalments, and at times a slight loss of control. Examination at this time may disclose merely slightly diminished capacity of the bladder, a few cubic centimeters of residual urine, with cystoscopic findings of only muscular hypertrophy in the bladder wall. It may be difficult to convince oneself that operation should be advised at this time, especially as the obstructing nodules of prostatic tissue may be so situated in the urethra or so small as to render the diagnosis impossible.

Presenting such a train of symptoms, a patient should be kept under close observation and if evidence of impaired compensation of the bladder muscle appears, operation should be advised at once.

This beginning second stage of the disease is the most desirable moment for operation for a number of reasons: The kidneys have not been long subjected to the effects of back pressure. The patient has not had his general health undermined from loss of sleep—due to nocturnal calls to evacuate the bladder. If 25 per cent. of cases of prostatic obstruction are liable to be of malignant nature, the chance of cure by re-

moval is greatest at this time. And finally, the disease is of a progressive nature with little hope of spontaneous cure or improvement. The most important point to be emphasized in this connection is that the size of the prostate, as felt by rectal examination or as outlined by cystoscopic examination, is not the determining indication for operation; but the effect that the obstruction to urination is producing upon the bladder and kidneys of the individual.

In the later stages of prostatic obstruction, other factors will obviously influence the time for operative intervention. These features will be considered in detail under treatment of the patient prior to operation.

The indications for operation in malignant disease of the prostate must be determined by the extent of the disease and the symptoms it is causing. If an early diagnosis has been made, removal should certainly be attempted irrespective of symptoms. In the later stages operation often renders the patient more comfortable by removing the obstruction to urination, even though death is the inevitable outcome.

OPERATION FOR THE RELIEF OF URINARY OBSTRUCTION

PROSTATECTOMY

Anatomical Points.—Our conception of the anatomic changes which the prostate undergoes during the phenomena of hypertrophy has been materially changed during recent years. This has been largely due to the research work of Tandler and Zuckerkandl. In a comprehensive series of dissections they proved that enlargement always begins in the glandular tissue situated around the urethra and behind the verumontanum.

The median lobe is now known to be a distinct and definite division in the glandular development of the prostate, and is so constant a factor in the production of urinary obstruction that it is time that its full significance were recognized.

Fully to appreciate the phenomena of prostatic hypertrophy, a knowledge of certain embryologic phases in the development of the gland is essential. As early as the third month of intra-uterine gestation, the mesoblastic tissue around the lower ends of the Müllerian and Wolffian ducts becomes thickened, in the situation of the wall of the primitive urethra (Wilson and McGrath). The epithelium of the sinus urogenitalis throws off 3 groups of buds on each side. Two of these are on the dorsal aspect of the urethra, beginning as a single mass and later dividing into a cranial and a caudal group. One is on the anterior aspect of the urethra.

The anterior group atrophies at an early period and is usually absent in the adult. These buds consist of epithelial tissue lying in a mass of mesoblastic tissue and do not acquire a lumen until after birth.

As the prostate develops to its final normal state, differentiation takes place in these different groups of glandular tissue so that definite zones appear. If the musculoconnective tissue is dissected away from the gland, separate lobes may be differentiated as follows: A small anterior group; 2 lateral groups; an interposed median lobe; and a posterior lobe or commissure.

The lobules of the different groups have fixed points for the emptying of their excretory ducts into the urethra, and for this reason the designation of lobes to the various groups may be given. The excretory ducts of the anterior lobe empty into the prostatic urethra on its anterior wall opposite the verumontanum, the ducts of the median and lateral lobes on the floor and sides.

The prostate is penetrated by the urethra and the ejaculatory ducts. At the base of the prostate these canals are separated by the median lobe, but are united anteriorly at the situation of the verumontanum.

In the majority of cases of prostatic enlargement this wedge-shaped mass of glandular tissue, the median lobe, is the starting point of hypertrophy and becomes the main factor in the production of urinary obstruction. The floor of the prostatic urethra is in relation to this lobe from the internal meatus to the colliculus. Anterior to the colliculus, the prostatic urethra is in relation to the posterior lobe or commissure. The urethra is not connected to the prostate gland by any ducts in front of the colliculus—at least, in cases of hypertrophy.

In regard to the morphology of prostatic hypertrophy, Runge and Chiari, in their recent research, have proved that in the largest percentage of enlarged prostates the process is an adenomatous overgrowth, independent of inflammation and neoplastic in character.

Another fact is pertinent, that there is no anatomical capsule to the prostate, when considered from a surgical point of view. The line of cleavage which simulates a capsule during operative removal is merely a layer of compressed glandular tissue at the periphery of the enlarging lobe. Such being the case, the portion of the prostate removed during operation is the adenomatous overgrowth of the centrally situated secreting glandular zones; the lobes of the prostate which are intimately associated with the urethra through the prostatic ducts, namely the lateral and median lobes.

Further, during the process of hypertrophy, the prostate, from being entirely an extravesical organ, becomes an intra- and extravesical one. The internal sphincter of the bladder has changed its position from apposition to the base of the prostate to a position encircling it.

Better to understand the mechanics of urinary obstruction due to prostatic hypertrophy, let us consider the various lobes of glandular tissue which compose the prostate as being inclosed in a cone (Fig. 1). The sides of the cone are formed of dense, unyielding vesicorectal fascia, the apex by the external sphincter muscle, and the base by the internal sphincter muscle. We will now suppose that the phenomenon of hypertrophy takes place in 1 or more of the lobes contained in this cone. Up to a certain point of enlargement the prostate will be contained within the cone, then it will force its way out, and follow the line of least resistance. This line of least resistance will be into the bladder, through perforation of the internal sphincter, since lateral advancement is limited by the dense capsule of rectovesical fascia and anterior advancement by the triangular ligament (Fig. 2).

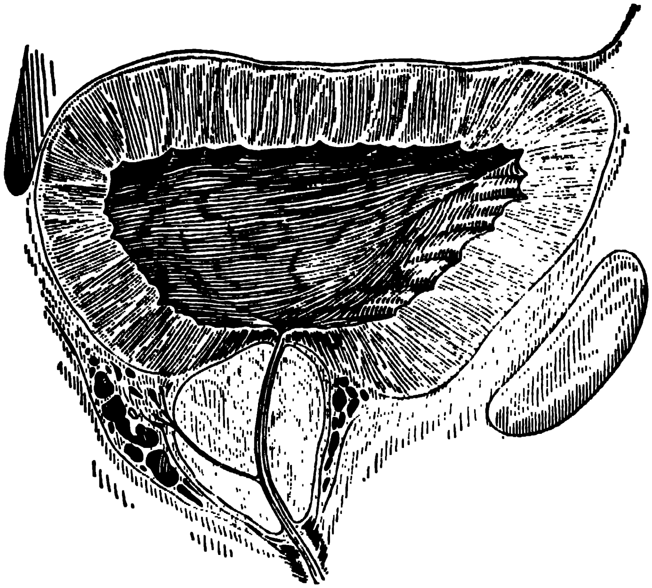

Fig. 1.—Diagrammatic Relation of Enlarging Prostate Before Becoming Intravesical.

The internal sphincter is forced outside the prostate as the enlarging lobe

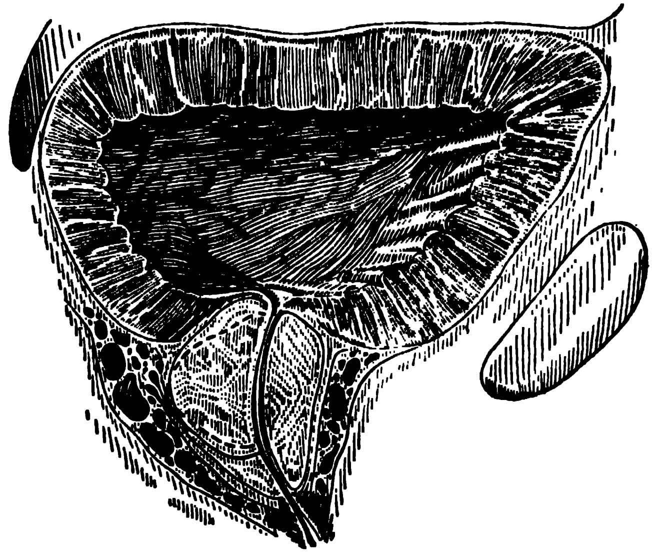

Fig. 2.—Beginning Enlargement of Prostate. Dotted line representing the normal position of prostatic base and ejaculatory ducts.

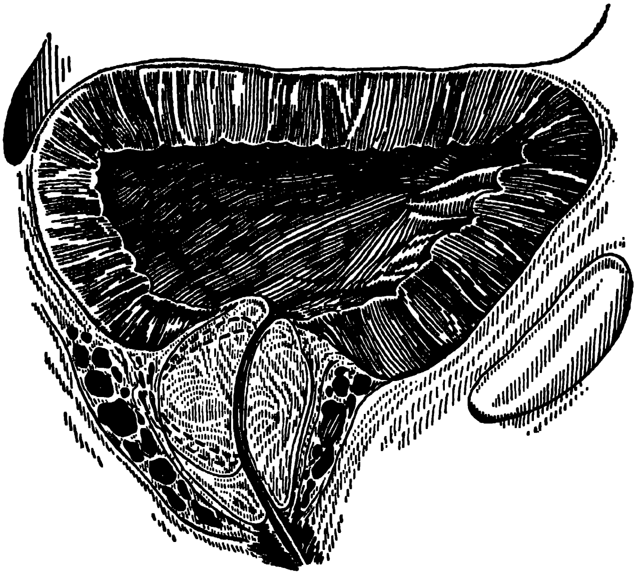

FIG. 3.—FURTHER DEGREE OF ENLARGEMENT OF PROSTATE. Internal sphincter muscle displaced outward: floor of urethra raised.

insinuates itself into the bladder between it and the bladder mucous membrane (Fig. 3).

Remembering that the glandular zones in contact with that portion of the urethra which is involved in the vesical neck are the commencing points of hypertrophy, it is seen that it requires but little increase in the size of these

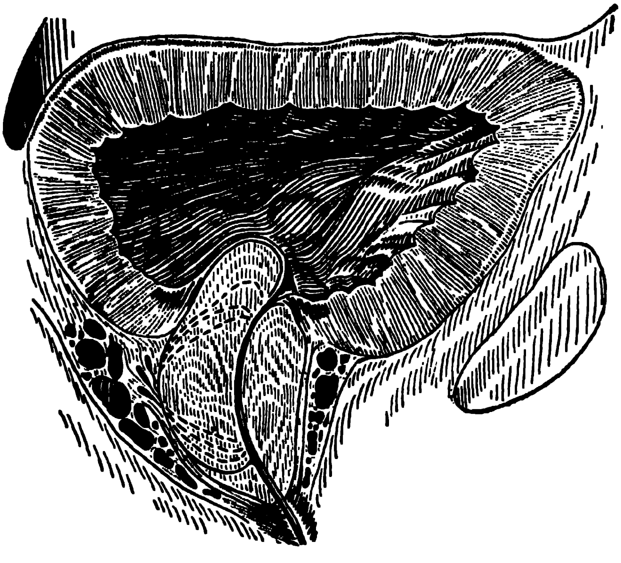

FIG. 4.—FURTHER DEGREE OF ENLARGEMENT OF PROSTATE. Internal sphincter constricts prostate; obstruction to internal meatus is complete; ejaculatory ducts displaced downward.

lobules, by pushing up from the floor of the prostatic urethra just at the internal meatus, to close effectually the bladder outlet to the flow of urine (Fig. 4).

Assuming that all obstructions to urination occurring in the course of true prostatic hypertrophies are due to the enlargement of the glandular zones which lie between the urethra and the ejaculatory ducts and above the verumontanum, we may expect to find the ejaculatory ducts pushed downward by the hypertrophy. They are covered by a layer of compressed prostatic tissue, are below the line of cleavage, and may escape injury during enucleation of the prostate. Hypertrophy of all parts of the prostate is never encountered, and atrophy of certain parts is always co-existent with hypertrophy. The posterior lobe of the prostate is rarely involved in hypertrophy, and, in fact, is usually in a condition of pressure atrophy.

This pressure atrophy probably explains the absence of glandular tissue in the posterior lobe of the hypertrophied prostate, in view of the fact that glandular tissue does exist in the posterior lobe of the prostate at the time of birth.

This brief outline of some of the more important anatomic changes in the prostate incident to hypertrophy has been taken up because a knowledge of them has a distinct bearing upon the question of the choice of method of operating for removal of the prostate. This will be referred to later under choice of operative methods.

An unusual type of hypertrophy is sometimes encountered, in which the hypertrophic changes are limited to the lateral lobes with no enlargement of the median glandular zones. The mechanics of urinary obstruction are different in these cases, since the lobes do not project into the bladder by piercing the internal sphincter muscle but enter outside the muscle. The muscle is thinned and remains encircling the prostatic urethra, and urinary obstruction is probably produced by compression of the prostatic urethra.

For an exhaustive exposition of the subject of anatomic changes in the prostate due to hypertrophy, the reader is directed to the classic monographs of Tandler und Zuckerkandl (4), Wilson and McGrath (6), and Lowsley (3).

Choice of Operative Methods.—Comparing the 2 methods of operative approach to the prostate, namely, the perineal and suprapubic routes, much may be said in favor of each.

Scarcely 25 years ago, surgical removal of the prostate was an unknown procedure, but since the time of Belfield's, Dittel's and McGill's early suprapubic partial prostatectomies and the early perineal operations of Ferguson, Billroth and Gouley, the question of the relative merits of each has ever been productive of discussion.

The early operations were incomplete, and it remained for Goodfellow, in 1891, to demonstrate the first total perineal prostatectomy, and for Fuller, in 1894, to demonstrate the removal of the entire gland by the suprapubic route.

Due largely to the writings of Fuller and Freyer upon suprapubic and Proust and Young upon perineal operations, strong adherents have been won over to each method. For years the method of operative approach has been the one most discussed while important factors more directly bearing upon the question of operative fatality have been ignored. Suprapubic prostatectomy was at first considered the operation of election, and then for a period the perineal route claimed considerable favor. It is only now, after 20 years' experience, that we are arriving at definite scientific conclusions concerning the matter. The criterion of judgment during the past has always been the comparative operative mortality of the 2 methods, and from a careful comparison of statistics, the results have seemed to favor the perineal advocates.

A number of influences have produced this apparent increased operative risk in suprapubic work. Notably among them is the fact that men have attempted the more simple suprapubic operation who have not been qualified to perform any type of prostatectomy—and hence the dire results. If the mortality records of surgeons equally skilled are compared, the percentage will not vary between the perineal and suprapubic operations.

Freyer, in 1912, reported 1,000 suprapubic operations with a 5½ per cent. mortality. For 100 consecutive cases the mortality has been 3 per cent.

Young has reported 200 cases with approximately the same rate of mortality. I would not leave the impression that I believe the real mortality of prostatectomy, meaning the mortality rate as it appears in the records of general hospitals, nearly approximates this low average. It is very much greater, and nearer 20 than even 10 per cent. Only at the hands of expert surgeons of wide experience in treating prostatiques may any such low mortality as 3 per cent. be hoped for.

Page gives the mortality of prostatectomy in 4 London hospitals, from 1906 to 1910, as 21.5 per cent.; 26 cases were operated upon, of which 16 died.

At the 1911 meeting of l'Association d'Urologie Internationale, Rovsing reported 25 prostatectomies, performed by himself, with a mortality of 16 per cent., and said:

> "We must not ourselves be led into believing that this (mortality report of Freyer and Young) is the real mortality of the operation as regards the great number of surgeons; you will find a far higher rate of mortality from this operation in the wards of the large hospitals all the world over. In my opinion, this is not due to different technic as compared with that of the specialist, perhaps, least of all so, but far more to the advanced stages of the disease of the cases. The true mortality certainly cannot be estimated at less than 10 to 20 per cent."

Henry Wade in his monograph on Prostatism, from research conducted in the Laboratories of the Royal College of Surgeons of Edinburgh (5), says:

> "Those statistics showing the mortality attending the treatment of prostatism are not reported by me to support the advocates of any of the alternative routes of operation employed, and I do not ask that undue importance be attached to them. What to me appears to be of great moment is the fact that the mortality attending prostatectomy, as practiced in general hospitals, has not shown in recent years that degree of

> reduction we might have been led to expect and what is of greater moment is that cases are occasionally seen that in the light of our present knowledge appear eminently to justify operative treatment. The operation proves simple and uncomplicated, and still the patient dies from causes that would appear to be virtually unavoidable."

In a paper read before the Medical Society of the State of New York, in January, 1909, I detailed the fatalities occurring in a series of 100 operations for removal of the prostate gland. Of these 100 cases, 71 were operated by the perineal and 29 by the suprapubic route.

Death, as a probable result of operation, took place in 7 instances, 4 following suprapubic and 3 perineal operations.

Another series was reported by me before the American Association of Genito-Urinary Surgeons in May, 1913, the vital statistics of which were as follows:

This group included 110 cases, operated upon since 1909, where it has been possible to follow the operative result from the time of operation to that of the report. Among the living, no case had been included that had not lived at least 1 year from date of operation.

With the exception of 3 patients operated by the perineal method, suprapubic intra-ureteral enucleation of the prostate had been the operation of election.

Ages:

From 50 years of age	5
From 50 to 60 years of age	26
From 60 to 70 years of age	57
From 70 to 80 years of age	16
From 80 to 90 years of age	6
	110

Thirty-six patients had suffered from primary symptoms only, and 74 from primary and secondary. Forty-one had been living catheter lives, exclusive of those who have had the catheter used in the treatment of the bladder and kidneys preparatory to operation.

Pathological changes in the gland:

Symmetrical adenomatous hypertrophy	62 cases
Typical median lobe obstruction	18 cases
Fibrous	17 cases
Carcinoma	10 cases
Tuberculosis	2 cases
Calculous	1 case

Complications: Calculi were present in 14 cases; strictures of the urethra in 3 cases. Strictures of the urethra complicated the case of calculous prostate. One case of median lobe obstruction in a Chinaman was complicated by urethral strictures (perineal operation).

One case of symmetrical hypertrophy was complicated by strictures. A primary urethrotomy had been performed 4 years before the prostatectomy. Recurrent vesical calculi were present before and after urethrotomy. There had been no recurrence of calculi following prostatectomy after a period of 4 years.

The Operative Deaths: Exclusive of the 10 cases of carcinoma, there were 7 deaths occurring in from 12 hours to 1 week following operation.

Patient	Age	Time After Operation	Cause of Death
H. L......	73	12 hours after operation..	Shock
M. O......	68	12 hours after operation..	Shock
M. T......	80	12 hours after operation..	Shock, postoperative hemorrhage
P. E.......	58	5 days after operation...	Anuria
P. R.......	71	5 days after operation...	Pulmonary embolus
P. H.......	63	5 days after operation...	Pulmonary embolus
B. D......	65	7 days after operation...	Anuria

Deaths Occurring after Convalescence from Operation to the Time of Report: Exclusive of the cases of carcinoma, 6 deaths occurred in from 2 months to 3 years after operation.

Patient	Age	Time After Operation	Cause of Death
D. E......	71	2 months..............	Acute gastro-enteritis
S. N.......	73	4 months..............	Endarteritis, nephritis
G. N......	65	18 months..............	Endarteritis, nephritis
A. S.......	69	2 years................	Apoplexy
W. R......	69	2 years................	Endarteritis, nephritis
H. Y......	63	3 years................	Diabetes

These statistics from my own experience would seem to further substantiate my belief that the method of approach for excision of the gland does not greatly influence the mortality rate of prostatic removal.

Deaver (1) states his position as follows:

> "In short, it is my contention, based upon personal experience and examination of the results of others, that the mortality of the two operations *per se* is approximately equal and that the factors influencing mortality are less to be sought for in the operation itself than in extraneous conditions, the most important of which are (1) the selection of the patient, either conscious selection on the part of the surgeon or unconscious, owing to the character of his practice; (2) to the preliminary preparation of the patient for operation; (3) to the skill of the operator, and finally, to rational after-treatment."

If, then, the operative mortality may be eliminated as a factor in choice of method, what shall be the main deciding feature? The answer is that the

choice of operation must be decided by the type of the disease presented by the individual case or by the presence of existing complications. To elucidate, 3 main varieties of disease lead to prostatism: (a) prostatic hypertrophy or adenomatous outgrowth; (b) chronic interstitial prostatitis or prostatic fibrosis; (c) prostatic carcinoma.

About 80 per cent. of all cases will come under the first heading, namely, prostatic hypertrophy.

Tandler and Zuckerkandl have proved that without exception hypertrophy affects the portion of the prostate turned toward the bladder and that the gland early develops an intravesical projection, the true cause of obstruction.

This type of disease, basing our judgment upon anatomic reasons, should, therefore, be removed by the transvesical suprapubic method.

The second type of the disease, chronic interstitial prostatitis, where the gland has undergone fibrous changes producing constriction of the vesical neck, is more easily dealt with by perineal route or by some form of transurethral operation. The very early cases of pure hypertrophy, with the obstructing lobules still within the urethra, may also be similarly operated.

Prostatic carcinoma, if diagnosticated in its incipiency, had best be operated by the perineal method, since it usually first makes its appearance in the posterior lobe of the gland. In extensive carcinoma of the prostate, with or without vesical involvement, suprapubic operation is indicated. Complete extirpation of the growth may be impossible in such a case, but an opportunity to employ a number of conservative procedures is thereby given, which may add greatly to the patient's comfort as well as to the prolongation of life.

A complication of prostatism, strongly indicating suprapubic operation, is calculous disease of the bladder.

SUPRAPUBIC PROSTATECTOMY

Instruments.—The instruments required are: scalpel, artery forceps, scissors, abdominal skin retractors, needle holders, 2 sizes of curved needles, and a rubber drainage tube of caliber 40 F.

Preliminary Precautions.—In performing prostatectomies, in most instances we are dealing with a class of patients who can little withstand any surgical procedure, and absolutely cannot stand any operation which necessitates prolonged narcosis. For this reason alone no detail of technic should be overlooked which will aid in lessening the time the patient is subjected to anesthesia during operation.

Death following prostatectomy by any method is usually caused by shock, renal insufficiency or pulmonary or cardiovascular complication. Shock following any surgical operation, leaving hemorrhage out of consideration, is in direct proportion to the length of time required to perform it and the amount of anesthetic the patient consumes. The ability of the kidney to properly functionate

is also reduced by prolonged anesthesia; therefore, indications exist for a rapid operation as well as for the conservation of the vitality of the patient in every way before, during and after the operation.

The technic which has greatly improved my results I shall give at length, as the carrying out of the little details is so essential. I am not trying to place before you a new operation for prostatectomy, but to show what I consider to be the points which are of importance in performing suprapubic prostatectomy, and some of the reasons for their importance.

In outlining this technic, we will assume that the patient to be operated upon is suffering from simple enlargement of the prostate without complications. Twenty-four hours previous to the operation the abdomen and pubes are shaved and thoroughly washed with green soap, and a dry sterile dressing applied. At the time of operation the patient is brought to the operating room and placed upon the table and the bladder is irrigated and distended with a sufficient amount of fluid. The operative field is sterilized by the tincture of iodin, 3 per cent., method. Sterile towels are placed on the patient, and he is made ready for operation before anesthesia is commenced. The advantage of this method of preparation is that the patient is not compelled to lie in a pool of water with the opportunity of a chilling of his body surface as by the old method of sterilization, where the final preparation consisted in soap and water scrubbing of the patient's abdomen, and application of alcohol and ether and solutions of bichlorid of mercury to the parts after the patient is under the anesthetic. Instead, he is kept warm and dry right up to the time when the incision is made.

After all preliminary preparation has been completed and the towels arranged, the surgeon is ready to commence operating, and not until then, is the anesthetic started.

Ideal Anesthetic.—My preference for anesthetic is nitrous oxid and oxygen. It requires, unfortunately, complicated apparatus and an anesthetist specially trained in its use. Full doses of morphin and scopolamin are given 1 hour before the time of operation. If for any reason the operation needs to be prolonged, ether may be substituted.

Crile's method of induction of anesthesia along the principles of anoci-association bids fair to supplant the use of nitrous oxid alone in those cases where the treatment of known existing complications will be time consuming.

The use of ether in urology has a distinct disadvantage; many patients die from destroyed cardiac compensation produced by an exacerbation of a chronic lung lesion induced by this anesthetic. Chloroform is probably less dangerous, if administered by one skilled in its use.

Spinal anesthesia is again being considered by a number of enthusiastic observers as the ideal method of anesthesia for urologic operations below the umbilicus. Surgical shock is claimed to be largely eliminated by this method. Cabot, who has had an extensive experience with the administration of spinal anesthesia reported as follows, before the 1914 meeting of l'Association Internationale d'Urologie:

"In general surgery the use of spinal anesthesia has considerable limitations. Although a large amount of work has been done by many competent observers, conviction is still lacking that spinal anesthesia can be used with reasonable safety for operations above the level of the umbilicus. Even with a comparatively low puncture in the second or even third lumbar interspace, anesthesia is frequently obtained up to the level of the nipple or even a little higher, but the upper limits of this anesthesia are uncertain. The anesthesia at these limits is incomplete, and one is likely to encounter the area of hyperesthesia which exists at the upper limits of the anesthetic zone. This limitation necessarily excludes a large proportion of the operations in general surgery but by the same token it does not interfere with a large proportion of the operations of urology.

"The second consideration in general surgery is the risk. In spite of the large amount of work already done and the frequent modifications of technic looking to an increase in safety, we believe that it still remains a fact that for persons whose condition gives no contra-indication to general anesthesia the method of spinal anesthesia is considerably more dangerous. Figures will not be at hand for some time to come, which will enable us to compare this method with that of general anesthesia in a number of cases sufficiently large to justify safe conclusions. On the other hand, for children, young people and adults of less than middle age, the general anesthetics are so safe as to make the use of spinal anesthesia a piece of experimentation, in which the surgeon ought not to indulge. It will be seen, however, that these objections, which will frequently bar spinal anesthesia in general surgery, are much diminished or do not exist at all in urology. We have already shown that the majority of our patients have lesions of the kidney, heart, or lung, which greatly increase the dangers of general anesthesia. We have already shown that on account of their age, with necessarily lowered kidney function, our patients are more likely to be unfavorably affected by shock than are the patients of the general surgeon, and finally, a considerable proportion of our operations are done below the level of the umbilicus. It therefore follows that the objections which limit the use of spinal anesthesia in general surgery are largely inoperative here. The dangers of ether in irritated conditions of the lung and in patients with high blood-pressure, the dangers of chloroform in patients with chronic endocarditis and the dangers of gas and oxygen in patients with disease of the cardio-vascular system, are such that if even we admit an anesthetic mortality for spinal anesthesia as high as 1 in 1,000, it may still remain the anesthetic of election. These facts should be clearly understood. It is not necessary for us to show that in a large number of cases of all kinds the mortality accompanying its use is as low even as the most dangerous of the general anesthetics, chloroform. We are of necessity dealing with patients having very special anesthetic peculiarities and I am firmly of the opinion that in many of these patients it is less dangerous than any of the general anesthetics, even granting against it the most unfavorable figures, and finally, its effect upon shock production must not be overlooked."

Operative Technic.—STEP 1.—The bladder is thoroughly irrigated and distended with ½ strength boric acid solution.

STEP 2.—An abdominal incision 7 to 10 cm. (3 to 4 in.) in length is made, extending from below the umbilicus to the pubes. This incision divides the skin and fascia and exposes the sheath of the rectus. The anterior sheath of the rectus is divided, its muscle fibers are separated, and the fibers of the pyramidalis muscle divided. Blunt dissection opens upon the prevesical space.

STEP 3.—The bladder is recognized by the characteristic venous arrangement on its surface and the peritoneum is gently pushed upward without opening into the general abdominal cavity. It is wise to make as little dissection as possible of the prevesical space to guard against infection of this region, as well as the production of hemorrhage by injuring its contained venous plexus.

STEP 4.—Two traction sutures of heavy silk are introduced into the bladder, the fundus of the bladder lifted into the wound, and gauze packing placed around the edges of the abdominal wound, to prevent soiling at the time the bladder is incised and its contents evacuated (Fig. 5).

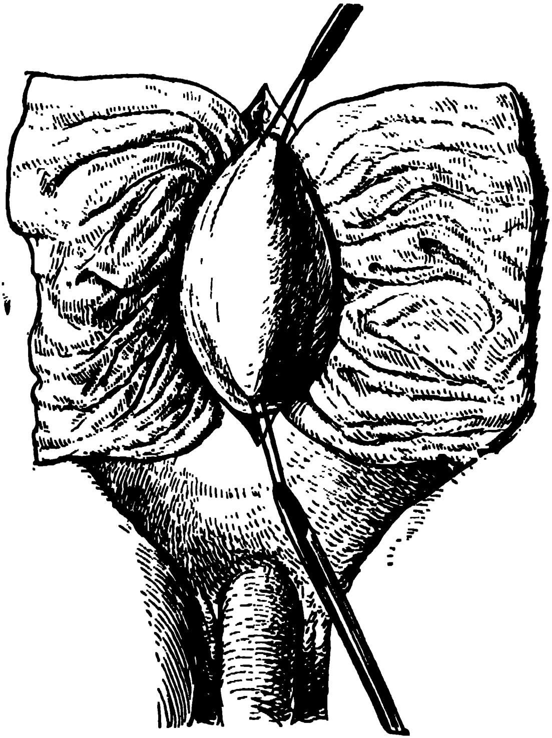

FIG. 5.—BLADDER DRAWN OUT OF WOUND AND EDGES PROTECTED BY GAUZE BEFORE BLADDER IS INCISED.

After one has acquired experience, the use of these traction sutures will become unnecessary, as the finger, pushed into the bladder incision as soon as it is made, serves better as a tractor than the sutures and plugs the hole until the fundus is pulled to the level of the abdominal incision, when further enlargement of the opening allows of its evacuation.

STEP 5: BLADDER INCISION.—The incision in the bladder, large enough to admit 2 or 3 fingers, should be made high up on the fundus close to the peritoneal reflection (Fig. 6). This may seem to be an unimportant matter, yet it has a direct bearing on the length of time required for the healing of the suprapubic sinus. A glance at Figures 8 and 9 will explain the reason at once. If the opening is made lower down behind the pubic bone, through fear of injuring the peritoneum or otherwise (Fig. 7), when the patient's convalescence

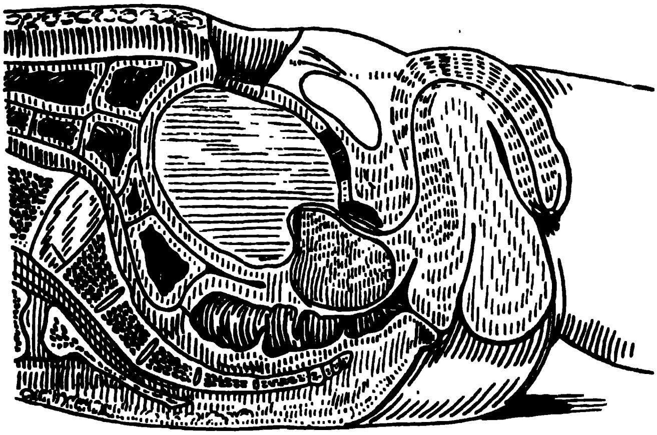

FIG. 6.—THE PROPER LOCATION OF BLADDER INCISION—HIGH UP NEAR THE PERITONEAL REFLECTION.

permits him to assume an upright position, the bladder opening of the suprapubic sinus is in a relatively dependent portion of the bladder, thus facilitating the constant escape of urine through the sinus. Such a condition will undoubtedly increase the length of time necessary for healing to take place. This is especially true in patients who have relaxed abdominal walls with large dilated bladders.

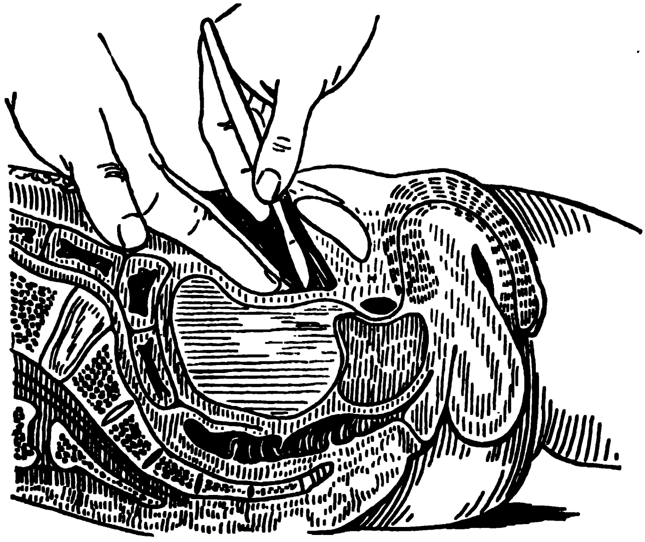

FIG. 7.—IMPROPER LOCATION OF BLADDER INCISION.

STEP 6: ENUCLEATION OF THE PROSTATE.—This method of enucleation can be readily understood by referring to the accompanying series of illustrations.

In Figure 10 is shown the symmetrically enlarged prostate projecting into the bladder, raising the urethral orifice and displacing the internal sphincter muscle outward away from the urethra. The lateral lobes are seen to lie in apposition just above the meatus.

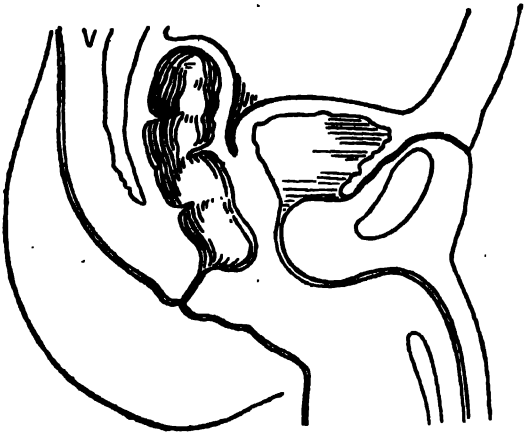

FIG. 8.—COURSE OF SINUS AFTER IMPROPER BLADDER INCISION.

Figure 11: Enucleation is commenced by pushing the finger into the internal meatus and breaking through the roof of the urethra at the point where the lateral lobes lie in apposition. The finger is necessarily within the encircling fibers of the sphincter.

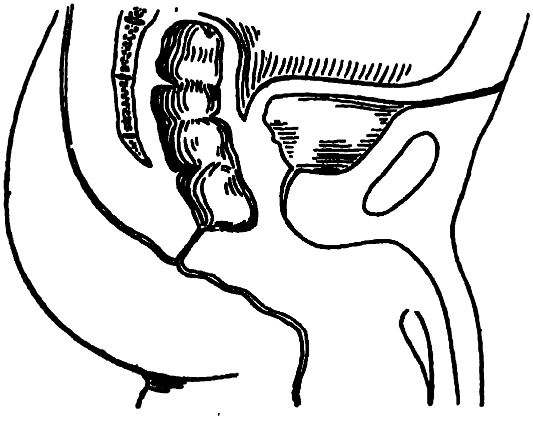

FIG. 9.—COURSE OF SINUS AFTER CORRECT BLADDER INCISION.

Figure 12: The finger frees the lateral lobe in front and at the side, and the lobe is delivered into the bladder.

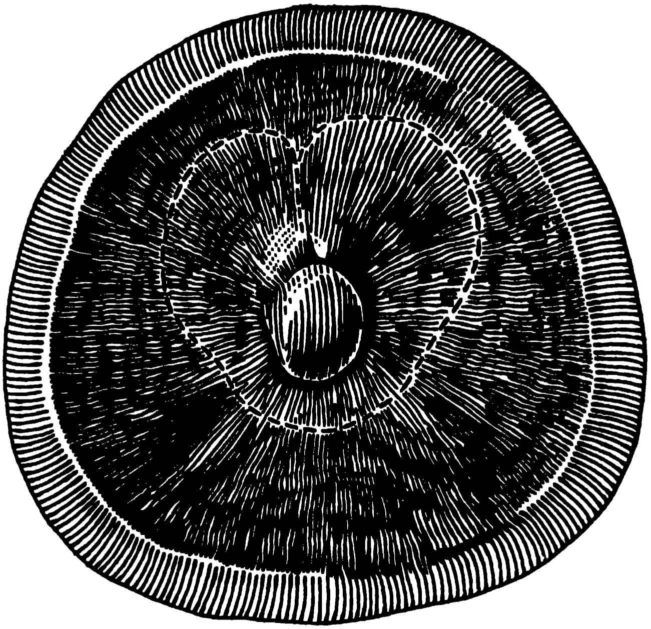

FIG. 10.—INTRAVESICAL PROJECTION OF PROSTATE. Dotted line shows the limit of lateral enlargement.

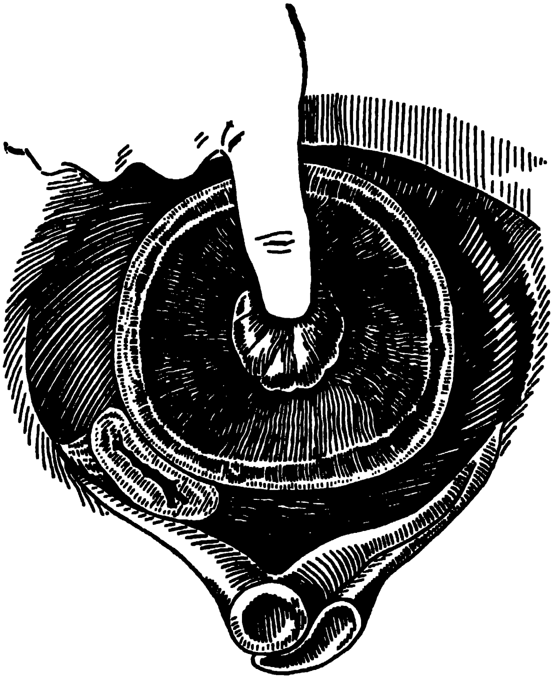

FIG. 11.—PROSTATE ENUCLEATION (1). Finger pushed into urethra from internal meatus.

Figure 13: The finger is carried around below the median lobe, the other lateral lobe is then loosened (Fig. 14), the prostate is tipped up in the bladder (Fig. 15), and the urethra severed close to the median lobe, posterior to the colliculus. An irregular cone-shaped cavity remains, lined with compressed prostatic tissue covering the uninjured ejaculatory ducts. The internal sphincter remains intact and soon contracts to its normal caliber. The cavity produced by removal of the prostate eventually contracts and repair becomes complete by the torn mucous membrane of the bladder uniting with that of the severed urethra. An assistant steadies the prostate through the rectum during enucleation. The operator should not do so, as it interferes with the immediate completion of the operation because of the necessity of resterilization of the hands and changing of gloves.

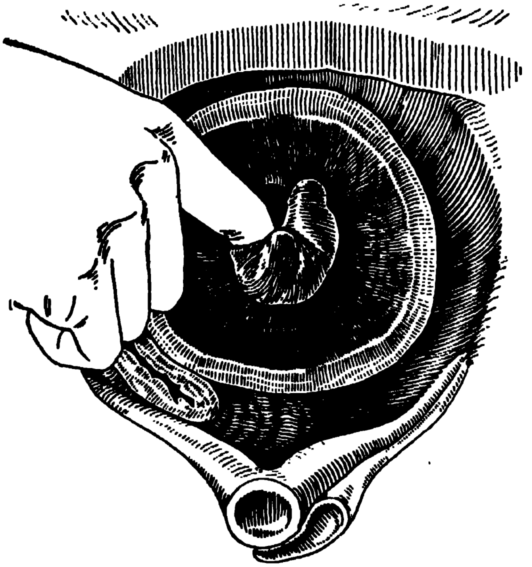

FIG. 12.—PROSTATE ENUCLEATION (2).

STEP 7: THE CONTROL OF HEMORRHAGE.—Having removed the prostate from the bladder, considerable hemorrhage is at once encountered. The bleeding comes from the region of the cavity formed by the removal of the gland and also from the torn edges of the bladder around the internal sphincter muscle. Ordinarily, a long strip of gauze wrung out in very hot salt solution and then packed into the cavity will suffice to check any active hemorrhage in a few minutes. Before the drainage tube is sutured into place and the bladder wound closed, this is removed.

Additional security against postoperative hemorrhage may be obtained by a number of devices. A catheter placed in the urethra and extending well into

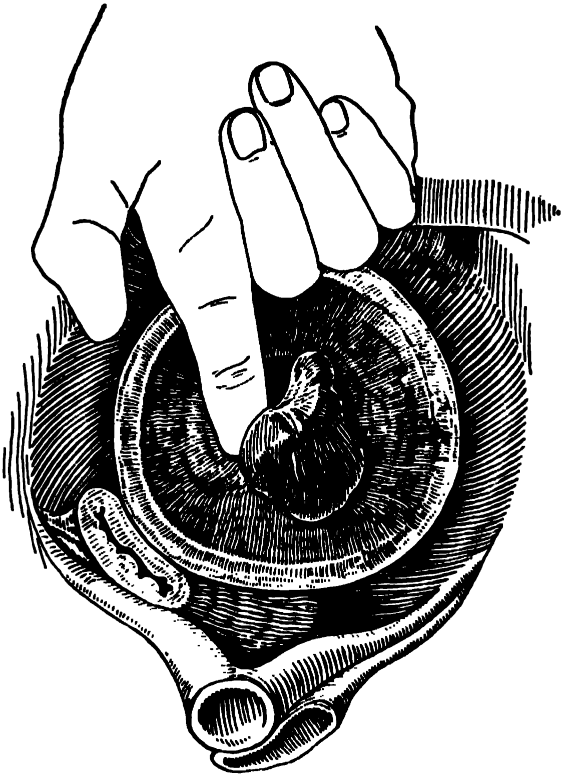

FIG. 13.—PROSTATE ENUCLEATION (3).

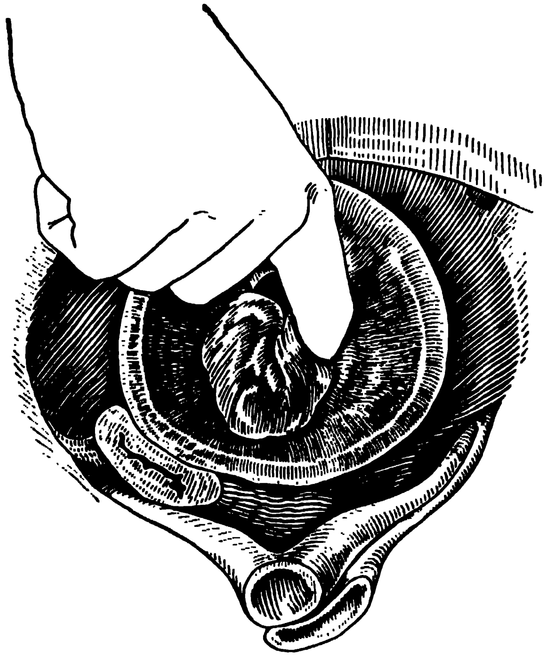

FIG. 14.—PROSTATE ENUCLEATION (4).

the bladder, with its bladder end wound with gauze, may be used; when the gauze-wrapped end is pulled into the prostatic cavity, the bleeding will be controlled. An objection is that a large unclosed bladder wound must be left to ensure the easy removal of the catheter. Cabot used a number of deep sutures to approximate the torn edge of the bladder and the walls of the prostatic cavity to check hemorrhage.

Keyes introduces a suture through the perineum, by means of a Reverdin needle guided into the deep urethra by a staff. This is then brought into the bladder, transfixes the lower border of the cut bladder mucosa, and is withdrawn. The process is repeated and this gives a firm traction suture upon the lower lip of the upper boundary of the prostatic cavity. The perineal ends of the suture are tied over a gauze roll. Traction exerted in this manner upon the bladder neck has been successful in controlling hemorrhage.

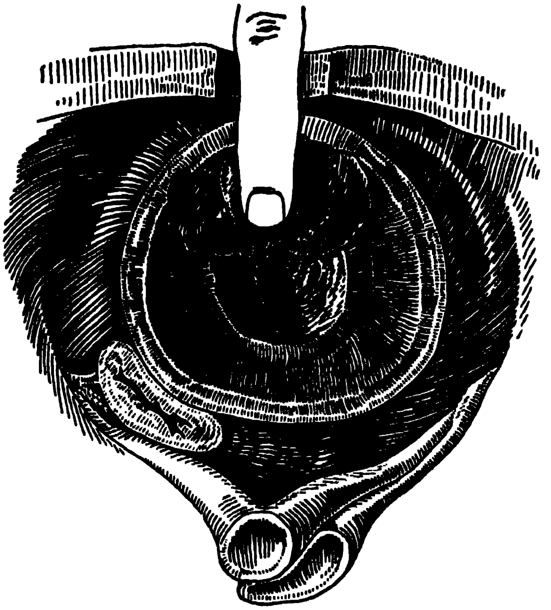

FIG. 15.—ENUCLEATION OF PROSTATE COMPLETED. Urethra seen at bottom of prostate cavity. Internal sphincter muscle undamaged.

Lower carefully packs the bladder neck and prostatic cavity in an effort to approximate the torn edges of the internal sphincter to the walls of the prostatic cavity. Attempts have even been made to suture the torn internal sphincter to the torn remnant of prostatic urethra anterior to the veru. This, however, is rarely possible. Hagner has made use of an inflatable rubber bulb attached to the end of a rubber tube to accomplish a similar purpose. The technic of its employment is as follows: After the prostate has been removed, a specially constructed sound is introduced into the bladder through the urethra. The rubber tube is slipped over the end of the sound and pulled out of the bladder through the urethra, leaving the deflated bulb in the bladder. Further traction upon the deflated end of the tube pulls the rubber bulb into the prostatic cavity. The bulb is then inflated, and the pressure thus exerted upon the bladder neck controls the hemorrhage. A suture attached to the bladder end of the bulb and brought out through a large suprapubic drainage tube allows of subsequent removal of the bulb and tube.

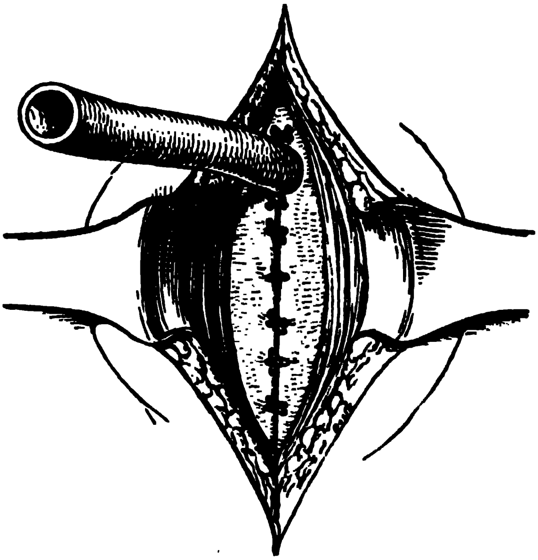

FIG. 16.—DRAINAGE IN POSITION AT UPPER ANGLE OF BLADDER WOUND.

If a proper careful enucleation of the prostate is performed, I have rarely found any of these devices necessary. However, as many surgeons believe that routine precautions against postoperative hemorrhage are imperative in these cases, any of the methods mentioned may be found useful.

STEP 8: CLOSURE.—The subsequent steps of the operation are completed as follows: A drainage tube is inserted into the bladder at the upper angle of the bladder wound and the lower angle sutured tightly up to the tube, for reasons which I have already mentioned in speaking of persistent fistulæ following prostatectomy (Fig. 16). A cigarette drain is introduced at the lower angle of the abdominal wound down to the prevesical space. The abdominal wound is closed by a few figure-of-eight silkworm-gut sutures, one loop approximating the fascia and the other loop the skin (Fig. 17).

Method of Fuller and Freyer.—In the field of suprapubic prostatectomy 2 other distinct types of prostatic enucleation are widely used. The first is that of Fuller, of the American, and Freyer, of the English, School, who advise making the bladder incision only large enough for the insertion of 2 fingers into the bladder, accomplishing removal of the prostate by starting the enucleation through an incision into the bladder mucous membrane over the most prominent lobe of the prostate. This method has 2 distinct drawbacks, namely, danger of hemorrhage on account of the possibility of the dissection becoming external to the so-called capsule of the prostate, and thus opening into the venous plexus of Santorini; and, also, danger of injuring the internal sphincter muscle of the bladder. By the method of blunt digital dissection, aided by counter pressure in the rectum to elevate the prostate, it is removed in one mass; generally with the commissure and that portion of the urethra above the verumontanum and ejaculatory ducts.

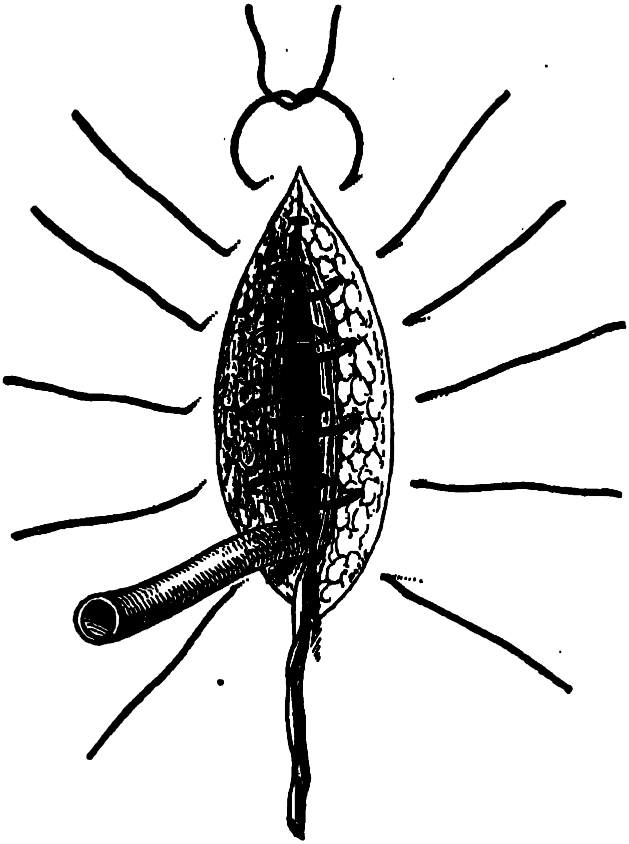

FIG. 17.—FIGURE-OF-EIGHT SUTURE CLOSURE OF ABDOMINAL WOUND.

Method of Tandler and Zuckerkandl.—The second method is one devised by Tandler and Zuckerkandl in the attempt to perform the enucleation under the guidance of the eye. The operative procedure is essentially as follows: Cystotomy having been performed, the edges of the bladder wound are well re-

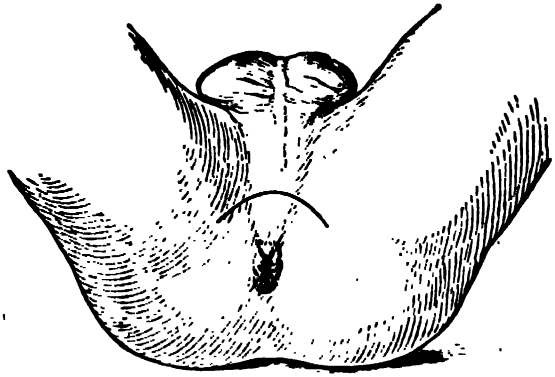

FIG. 18.—SKIN INCISION FOR PERINEAL REMOVAL OF THE PROSTATE.

tracted and the interior of the bladder visually examined. The most prominent portion of the prostate is definitely ascertained, also the position of the trigone and the positions of the ureteral openings. An incision is made encircling the

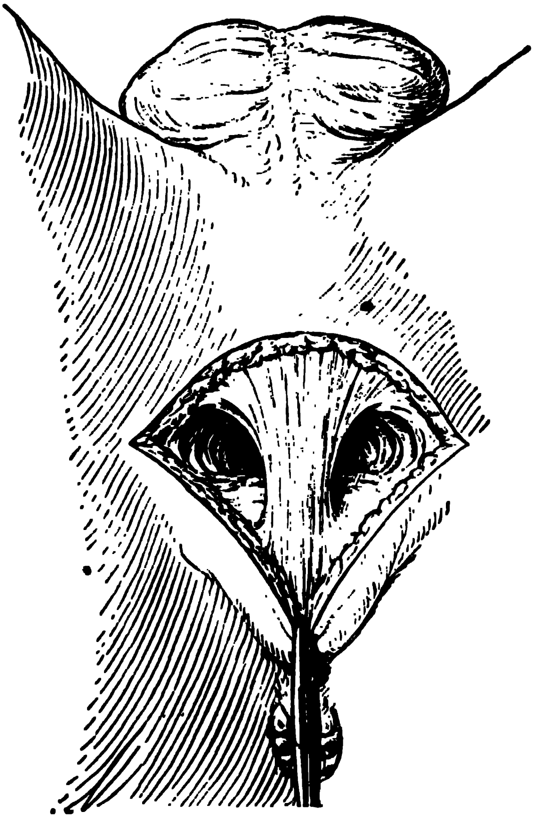

FIG. 19.—SPACES ON EITHER SIDE OF MEDIAN TENDON OF THE PERINEUM OPENED UP BY BLUNT DISSECTION.

urethral opening, the exact location of the incision depending upon whether the hypertrophied prostate projects into the lumen of the bladder or whether, in the absence of such a prominence, the entire trigone is elevated. In the first case, the incision must be made centrally from a limiting groove between the prostatic mass and the vesical wall. Here the opening of the urethra is to be considered the center. This groove indicates the position of the internal vesical sphincter muscle. A deep incision made peripherally to this groove may pass to the outer surface of the prostate and partially destroy the sphincter, therewith involving the question of functional restitution. By such a procedure, as with the Fuller operation, the veins of the plexus of Santorini may be injured and cause severe, even fatal hemorrhage; finally, in this way it is also possible to open the connective-tissue fasciæ of the pelvic floor. An indication of this incorrect course, in which the removal is extracapsular, is the fact that in its removal the prostate must first be free from seminal vesicles and ductes deferentes, which are visible in the wound.

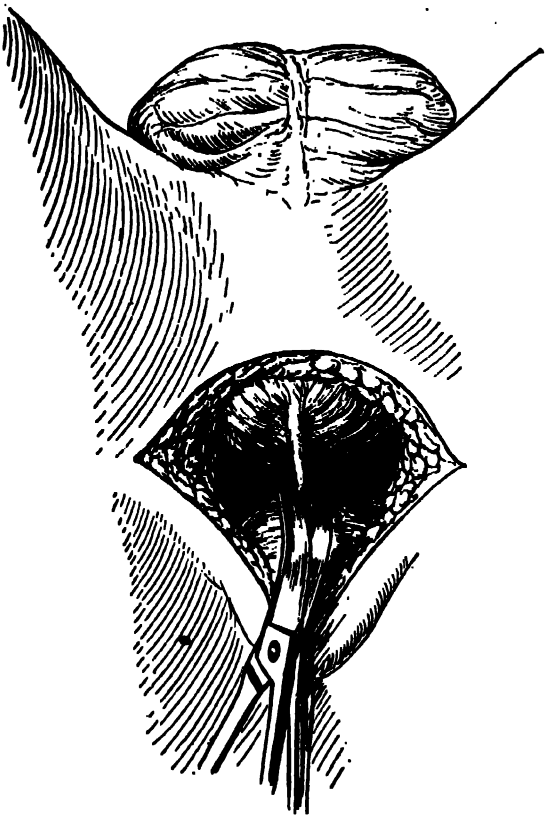

FIG. 20.—EXPOSURE AND DIVISION OF MUSCULAR ATTACHMENTS BETWEEN URETHRA AND RECTUM.

If the hypertrophied prostate does not project into the bladder, incision can be made nearer to the vesical opening, yet not too closely, or in the urethral canal, since in order to avoid a recurrence, the submucous prostatic elements should be removed with the hypertrophied organ.

The tumor is then to be freed as completely as possible from the vesical wall and the sphincter. This separation is accomplished easily when made in the correct plane. The smooth-walled mass is soon freed on all sides and is only fixed at the base by a pedicle of the distal portion of the prostatic urethra. If this pedicle is torn through, which usually happens, it is a matter of chance whether the point of separation will be proximal or distal to the colliculus seminalis. Therefore, it is proper, after enucleation of the tumor, to sever the urethral pedicle as nearly as possible to the surface of the mass. This is accomplished with a curved scissors and by approaching the pedicle along the posterior border of the isolated tumor. By so doing, injury to the colliculus seminalis and the ductes deferentes is avoided. (Wilson and McGrath.)

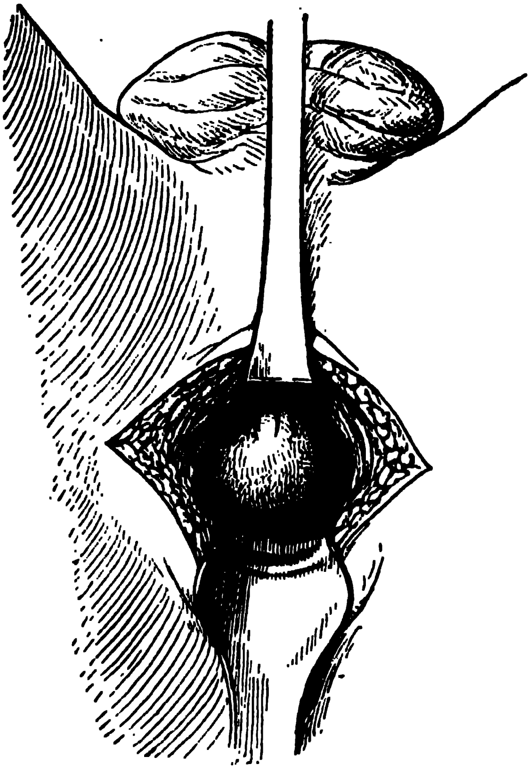

Fig. 21.—Location of Incision into Membranous Urethra for Introduction of Young's Prostatic Tractor.

This operation seems to be a needless dissection, and I doubt if by such a dissection, carried out under the so-called guidance of the eye, many advantages are gained over an enucleation performed by sense of touch; provided, of course, that said enucleation is commenced and continued as outlined previously. The main points in favor of an operation performed by visual dissection would be more accurate removal and better control of hemorrhage. It is questionable, however, whether these advantages will be found to offset the increased mortality rate of this open dissecting method, which is, as recorded by its chief exponent, Zuckerkandl, about 20 per cent.

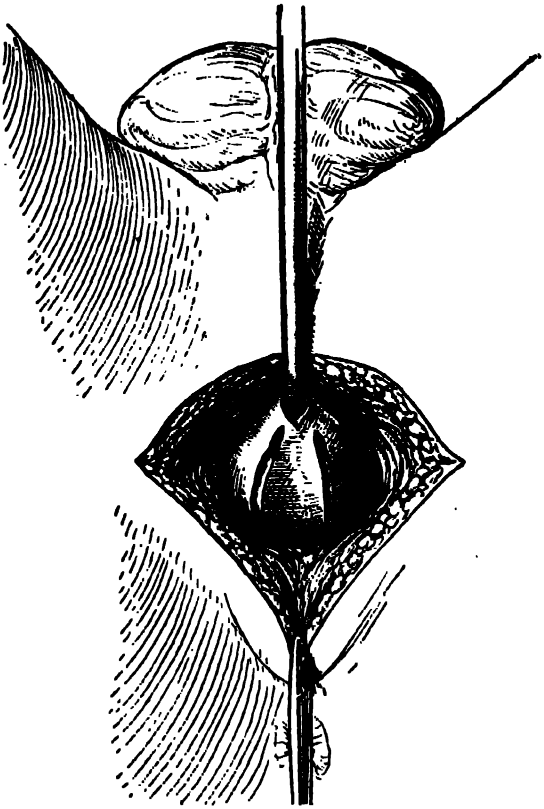

FIG. 22.—PROSTATIC TRACTOR IN PLACE AND LATERAL CAPSULAR INCISIONS MADE.

Two-stage Prostatectomy.—This heading is used to designate the operation of prostatectomy when performed in 2 stages, the first stage being a preliminary cystotomy with drainage of the bladder, and the second stage being the enucleation of the prostate, performed at some future period, days or weeks having intervened.

The 2-stage operation has the support of many surgeons, and some have even gone so far as to recommend it as a routine procedure. The preliminary cystotomy is performed under local anesthesia and suprapubic drainage of the bladder instituted; further operative intervention being postponed until a marked improvement in the patient's condition has taken place, making the second stage of the operation, namely the prostatectomy, less hazardous. There is a place for the 2-step operation of prostatectomy, but in my own experience I have found it to be only occasionally indicated.

There are but few patients who cannot be equally as well handled by bladder drainage carried out through the urethra, either by continuous catheterization or catheterization at intervals, as by suprapubic drainage. In my judgment, the operation should be reserved for those patients in whom catheterization is impossible or difficult, and I am unable to discover that the operative mortality of prostatectomy is less among those surgeons who perform 2-stage prostatectomy as a routine than among those who do not.

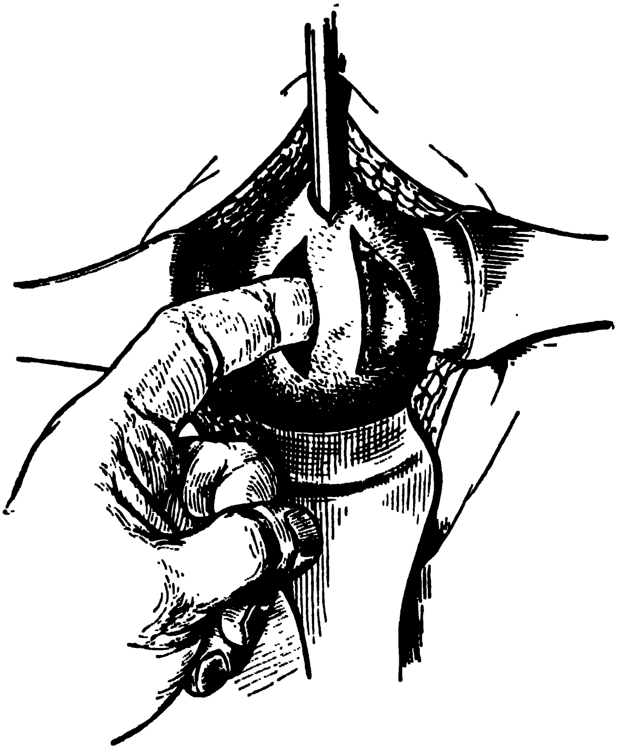

Fig. 23.—Removal of Intravesical Portion of the Prostate Through Lateral Opening.

Perineal Prostatectomy

Anatomic Points.—To perform perineal prostatectomy successfully, an intimate knowledge of the anatomy of the perineum is essential. One of the chief reasons why the perineal operation of prostatectomy has been replete with poor results, is largely due, in my judgment, to the fact that many operators have attempted it without having a definite appreciation of the importance of conserving the integrity of the external sphincter muscle as well as a knowledge of how to do so.

The prostate is in relation to the triangular ligament and the peritoneum below, the levator ani at the sides, the pubes in front, the rectum behind, and the bladder and seminal vesicles above. Those fibers of the levator ani beginning at the back of the pubis are carried backward around the antero-lateral aspects of the prostate and unite beneath it, blending with the fibers of the transverse perineal and external sphincter ani muscles at the central tendinous point of the perineum. To this portion of the levator ani muscle Santorini has given the name "levator prostatæ." Between the anterior part of the prostate and the rectum is a small muscle known as the recto-urethralis. It is attached in front to the posterior border of the triangular ligament and the membranous urethra, and runs backward and is inserted into the anterior wall of the rectum. The anterior portions of the levator ani muscle which encircle the sides of the prostate and membranous urethra are more or less fused with

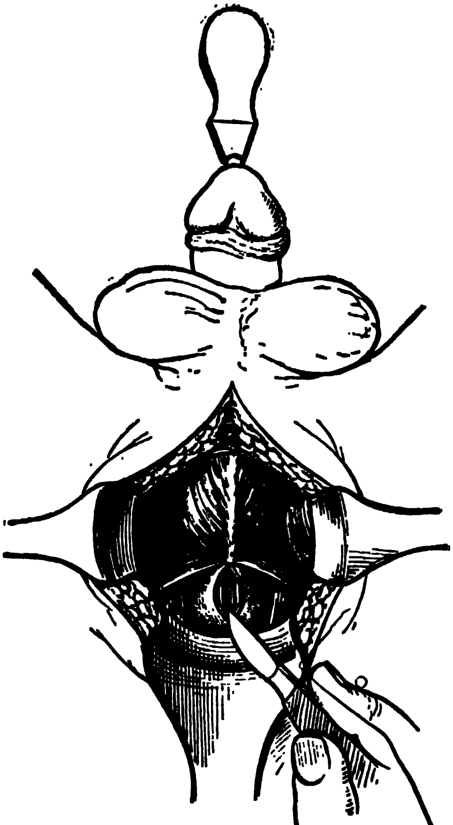

FIG. 24.—MEDIAN PERINEAL PROSTATECTOMY. Incision into membranous urethra.

the recto-urethralis. These muscle structures must be identified and properly cared for to ensure perfect result after operation.

The French School, as represented by Proust and Albarran, was the first to elaborate an exposure of the prostate by a transverse perineal incision extending through the levator ani muscle. The prostate was excised piecemeal, and

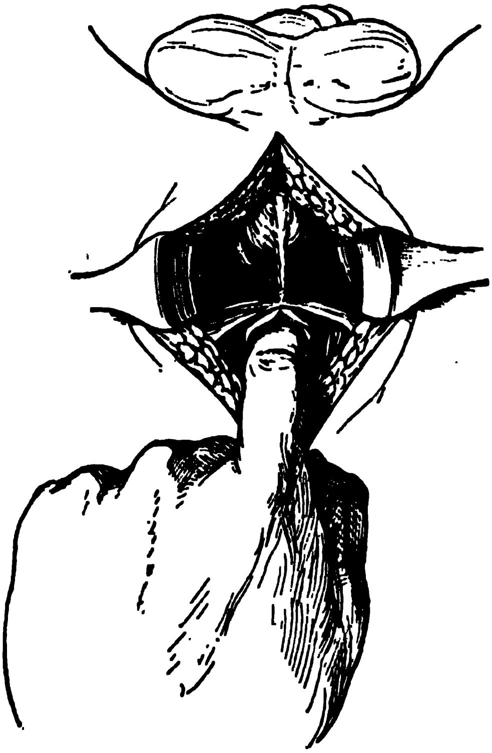

FIG. 25.—MEDIAN PERINEAL PROSTATECTOMY. Commencing enucleation of prostate through urethra.

the ejaculatory ducts regularly destroyed and often ligated, with practically no attention paid to preservation of the urethra. Improvements upon the operative technic of Proust and Albarran, as introduced by Young of Baltimore, have resulted in the perineal operation of election of the present day.

Instruments Necessary.—The instruments required are: Scalpel and bistoury, artery forceps, scissors, forceps, needle holders, half curved needles, perineal retractor, urethral instruments, Young's prostatic retractor, sounds and staff.

Position of the Patient.—The perineum should be so elevated that it is almost parallel with the floor, thus allowing excellent retraction of the rectum and exposure of the posterior surface of the prostate.

This is accomplished by placing the patient in an exaggerated dorsal position with the legs flexed on the thighs and the thighs flexed on the abdomen.

Before placing the patient in this position, a No. 24 French sound should be inserted into the urethra to be used as a guide for urethrotomy. The advantage of this is that, if the operator waits until the patient has been put into the position for prostatectomy before the introduction of the sound, in many cases it will be found very difficult or impossible to properly introduce the sound into the urethra.

Operative Technic.—STEP 1: INCISION.—An inverted V-shaped incision should be made with its apex just over the posterior part of the bulb and about 5 cm. in front of the anus. The lateral arms of this incision are directed outward and backward parallel to the ischiopubic ramus and are about 5 cm. in length (Fig. 18). The incision is carried through the skin, fat and superficial fascia, and the median tendon of the perineum is exposed. By blunt dissection with the index finger, the space on either side of the central tendon is opened up as far as the triangular ligament. In performing this dissection the levator ani muscle is shoved backward and upward on either side and the transverse perineal muscles are pushed forward (Fig. 19).

STEP 2: The central tendon of the perineum is now divided with a scissors, and the attachment of the urethra to the rectum exposed. The recto-urethralis muscle is exposed after severing the central tendon of the perineum (Fig. 20). The fibers of the recto-urethralis muscle are now cut close to the bulb of the urethra, care being taken not to injure the bulb and thus induce troublesome hemorrhage. The bulb having been freed and the fibers of the recto-urethralis muscle covering the membranous urethra having been divided, the rectum is pushed backward and a good view of the membranous urethra obtained. The membranous urethra is then opened upon the sound and the edges picked up with Allis clamps, being sure to include the mucous membrane in the grasp. At this point in the operation, the sound in the urethra is withdrawn, and a Young's prostatic tractor with its beak closed is introduced through the opening in the membranous urethra into the bladder (Fig. 21).. A posterior retractor is now placed in the wound and traction made backward, thus exposing the surface of the prostate. The blades of the Young's prostatic tractor are now opened and turned at right angles to the shaft and securely locked. Traction is made upon the prostate and further separation of the rectum from the posterior surface of the prostate carried out. The attachments of the rectum to the prostate in this situation are often so intimate as to make separation rather difficult. The dissection should, therefore, be made with extreme care for fear of injuring the rectum or opening into its lumen. The rectum is pushed backward exposing the fascia of Denonvillier covering the posterior surface of the prostate.

STEP 3: INCISION OF THE CAPSULE.—Two lateral tractors are now made use of, and with the posterior tractor and the prostatic retractor it is possible to get complete exposure of the posterior surface of the prostate. Two lateral capsular incisions are now made on either side of the median line for almost the entire length of the posterior surface of the prostate. The aim of these 2 incisions is to leave a bridge of prostatic tissue containing the ejaculatory ducts and the floor of the urethra outside the field of enucleation (Fig. 22).

STEP 4: ENUCLEATION OF THE LATERAL LOBE.—Through these lateral capsular cuts, the so-called capsule is separated from the posterior and external surface of the lateral lobes on either side by blunt dissection. This dissection is carried out by means of the handle of the scalpel or a blunt dissector. The urethral surfaces of the lobes are similarly separated, and the firm adhesions to the capsule at the apex of the lobes divided with scissors. The index finger is used to complete the enucleation, and the lobes are delivered through the capsular cuts, first one lobe and then the other. The median lobe, if present, is now engaged in one of the blades of the prostatic tractor and an effort is made to deliver it into the cavity remaining after removal of the lateral lobe (Fig. 23). The lobe is then grasped with a lobe forceps or an ordinary sponge holder and separated from the bladder mucous membrane and its adhesions and removed. The prostatic tractor is now withdrawn, a double current perineal drainage tube is introduced into the bladder through the opening in the membranous urethra, and the lateral cavities formed by the removed prostate are packed with gauze to prevent venous oozing.

The removal of the middle lobe or the intravesical projection of a prostatic hypertrophy is the stumbling block of the perineal operation. It is a comparatively simple procedure to remove a small prostatic intravesical outgrowth through a median incision or through a lateral capsular cut, but in those cases where the major portion of the hypertrophy is intravesical it may be very difficult. The intravesical projection of the prostate may be so large that removal through the lateral capsular cuts is impossible without extensive tearing of the urethra, often extending into the membranous portion. Such a removal of the hypertrophied mass will so damage the compressor urethræ muscle as always to interfere with its proper function. The intravesical hypertrophy of the prostate may be so large as to necessitate its removal by morcellation. In such an event, the possibility of leaving a small lobule of prostatic tissue behind is very great. Such an overlooked lobe of prostate may be all that is necessary to block effectually the internal urethra and so defeat the purpose for which the operation was undertaken. A careful search of the bladder interior and its vesical neck with the finger should, therefore, always be made before completion of the operation.

STEP 5: CLOSURE OF THE WOUND.—The prostatic tractor having been removed from the urethra, a rubber 2-way drainage tube is introduced into the bladder through the incision in the membranous urethra and sutured in place. The prostatic cavities are packed with gauze to control any venous oozing, the ends being brought out through the perineal wound. All retractors are removed from the wound and the edges of the levator ani muscle are brought together by a few stitches of catgut and the skin wound approximated by stitches of silkworm-gut. The perineal tube draining the bladder and the gauze packing leading to the cavities made by enucleation of the prostate are placed at the apex of the skin incision.

Median Perineal Prostatectomy

This operation is the older form of perineal prostatic removal and was developed along the line of an external urethrotomy. Instruments required are similar to those required for the operation just described and the position of the patient upon the table is similar.

Technic of Operation.—A staff having been introduced into the urethra, a median perineal urethrotomy is performed and the urethra opened upon the staff in the region of the membranous urethra. The edges of the opening into the urethra having been secured by means of artery forceps or silk traction sutures, the incision is enlarged sufficiently to admit the index finger (Fig. 24). The index finger is pushed into the urethra through this opening until the prostatic urethra is reached (Fig. 25). The wall of the prostatic urethra is punctured by the finger nail and an intra-urethral enucleation of the prostate carried out. No attempt is made to conserve either the ejaculatory ducts or any portion of the prostatic urethra or the colliculus. The operation is simply a blind enucleation of the prostate, and when the prostate has been freed from its adhesions by blunt dissection, it is grasped by a forceps and delivered through the opening into the urethra. This operation has nothing whatsoever to recommend it. It is absolutely unsurgical, and in the event of removing a prostate of any considerable size, carries with it the destruction of the external compressor urethræ muscle with an almost certain eventuality of postoperative urinary incontinence.

In contrasting perineal and suprapubic prostatectomy, one statement is definite. The approach to the prostate transvesically should always be intra-urethral, whereas enucleation of the prostate through the perineum should invariably be made through a lateral capsular cut. This statement is made not because I believe that the method of lateral capsular cut, with preservation of an intermediate bridge, carries with it any guarantee whatsoever that conservation of the ejaculatory ducts takes place, but that by starting enucleation in this way one gets behind the posterior lobe and therefore enters the proper line of cleavage of compressed prostatic tissue; and also that there is less danger or liability of serious injury to the compressor urethræ muscle, preservation of which is the important factor of any prostatectomy.

The possibilities of re-forming of obstruction from any unremoved prostatic tissue is unquestionably greater when the operation is done through the lateral capsular cut; nevertheless, this would not seem to be as much of an objection as permanent incontinence of urine resulting from operation.

PARTIAL PROSTATECTOMY OR PROSTATOTOMY

The early operation of partial prostatectomy or prostatotomy was devised in an attempt to get away from complete prostatectomy, on account of the various dangers and the high rate of mortality connected with the radical operation. No attempt was made to differentiate between the types of prostatic obstruction most suitable for its performance. As our ideas have taken definite shape concerning the various types of prostatic hypertrophy or prostatic obstruction, we have come to recognize that a certain small group of cases may be better handled by some form of less radical operation than complete prostatectomy. In the light of our present experience, partial prostatectomy is an operation reserved for the lesser forms of prostatic enlargement or prostatic obstruction, and especially for those types which are known as obstruction due to bars at the vesical neck, or to some small lobulated hypertrophy situated at the internal vesical sphincter. The various methods of accomplishing prostatotomy will be considered in 2 groups, namely, a group in which cauterization of the prostate is the essential feature, and a group in which the obstruction is removed by intraurethral excision without external incision.

CAUTERIZATION OF THE PROSTATE

Bottini Operation.—Bottini devised a galvanocautery instrument constructed on the principles of the lithotrite, the male blade of which was equipped with a platinum tip capable of being heated to white heat by means of electricity. The instrument was introduced into the bladder and its beak turned down, so as to engage the prostatic obstruction. The electrical current was now turned on, which heated the male blade of the instrument to a white heat. Traction made on the male blade forced it to burn through the prostate, until, in the operator's judgment, the obstruction had been removed. A serious drawback to this instrument was the fact that no provision had been made against overheating of the shaft, and in many instances extensive burning along the whole length of the urethra took place with resultant sloughing of the urethra and subsequent stricture formation.

Freudenberg modified the Bottini instrument by the addition of an irrigating apparatus, by means of which a current of cold water was made to circulate through the instrument during its employment and thus remove the danger of burning other contiguous tissues than the obstructive ones.

My experience with the Freudenberg modification of the Bottini operation has been limited to 65 operations. These were performed some 10 years ago, and the results were so discouraging that its use was abandoned. The operation was not devoid of danger and carried with it a mortality. The convalescence from the galvanocautery operation in many instances was far more tedious and painful than the average convalescence from a prostatectomy. The assurance of good results, as far as the relief of the urinary obstruction was concerned, was problematical before operation, and frequently the patient derived little benefit. The last patient on whom I performed a Bottini operation died of a rapid sepsis within 36 hours from the time of operation. The operation has fallen by the wayside and has no place in modern prostatic surgery.

Chetwood's Modification of the Bottini Operation.—Chetwood has modified the technic of the Bottini operation by introducing the Bottini-Freudenberg instrument through a median perineal urethrotomy incision, and has also shortened the total length of the instrument, so that it can be more easily managed through the perineal incision.

Recognizing that a circular sphincteric prostatic stenosis may occur as a cause of prostatic obstruction, his operation is particularly intended for the relief of urinary obstruction produced by such a condition. The advantage of the operation over the Bottini is very great. After the preliminary urethrotomy has been performed, the bladder neck is carefully examined by the finger and the extent of the obstruction made out. Indication as to the depth of the necessary cauterization is thereby ascertained. The convalescence from the operation is made more comfortable by bladder drainage through the perineal incision, and some of the objectionable features of the Bottini operation as practiced through the urethra are eliminated.

TECHNIC OF OPERATION.—Chetwood's description of the technic of this operation is as follows: "Local, instead of general, anesthesia may be employed. A urethrotomy through a small perineal cut is made, which brings the operator close to the site of trouble and allows the introduction of the index finger to investigate the condition at the neck of the bladder and the degree of contraction existing. The galvanocautery knife is then introduced and, under electrical cauterization, the vesical obstruction is incised on one or both sides, to such an extent as may be deemed advisable; this is accomplished without hemorrhage during or after the operation. The finger may be then reintroduced to ascertain the completeness of the incision or defect thereof; in the latter instance, it may be supplemented by another or longer incision. Finally, rest of the bladder, avoidance of the straining insured by the absence of the necessity to urinate after operation, the short period of confinement and radical removal of the cause, are all advantages to be counted."

RESULTS.—Keyes, who with Chetwood has had a very considerable experience with the Chetwood-Bottini operation, records his results as follows (2):

"During the past 10 years I have employed the Chetwood operation for about one-quarter of my cases of prostatic hypertrophy. I have also employed it for the removal of all minor obstructions, such as bars and contractures at the bladder neck, when simple perineal section is likely to prove inadequate to afford a proper drainage for the bladder. In selecting cases for such an operation one is likely to err on the one hand in operating upon patients with little or no retention, but suffering from painful and frequent urination, and who would do as well without operation upon the bladder neck; or on the other hand in attempting to relieve by cauterization an obstacle requiring prostatectomy. Beginning with 2 operations in 1901, I have performed 67 Chetwood operations, with 2 deaths, both due to sepsis; 1 on the thirteenth day; 1 at the end of the fourth week. A third patient was operated upon for complete prostatic retention. He left the hospital in 3 weeks, healed—emptying his bladder and in satisfactory general condition. Three weeks after this he died, his death being apparently due to chronic colitis. He had no further urinary symptoms and I do not believe that the operation hastened his demise.

"Of the remaining cases some failed to be cured for 2 reasons—either the prostatic obstacle was not sufficiently removed (in which case the patient continued to have residual urine, and after a lapse of time the symptoms returned or increased) or the obstacle was too fully removed leaving the patient with incontinence of urine.

"Among the 67 cases operated upon, 26 have been followed for a year or more (omitting cases of carcinoma, tabes, and tuberculosis). Seventeen or 66 per cent. of these patients were cured and the cures verified for 9 years in 1 case; 7 years in 3 cases; 6 years in 1 case; 5 years in 1 case; 4 years in 2 cases; 3 years in 4 cases; 2 years in 1 case; and 1 year in 3 cases. Three cases have great incontinence of urine; 2 incomplete and 1 complete. Six cases were incompletely relieved, and of these, 2 went as long as 5 years before their symptoms again really inconvenienced them.

High-frequency Cauterization.—This form of treatment, while of recent origin, has sufficiently proven its value to warrant description here. The first cases showing definite satisfactory results were reported by McCarthy to the New York Academy of Medicine, and his description of the method and the indications requisite to its successful employment would appear to place it under its proper category.

CONTRA-INDICATIONS.—The employment of the high-frequency cauterization of early intravesical prostatic intrusions or lobular outgrowths of the prostate should not be considered in advanced stages of prostatic enlargement nor in debilitated subjects, nor in such cases as show well-defined secondary bladder changes, such as marked cystitis, trabeculation, etc.

INDICATIONS.—Success may be anticipated in such cases as may well come under the heading of early prostatiques, having a moderate amount of residual urine with increased nocturnal frequency of urination, particularly in the so-called ball valve and lobulated prostatic outgrowth or bar formation.

TECHNIC.—The operation may be performed with or without local anesthesia. While this form of intravesical operation may be performed with the aid of any good catheterizing cystoscope, a more perfect instrument has been devised by McCarthy and is known as the McCarthy cystoscope. This instrument is introduced well into the bladder, and while in this position a high-frequency wire (Fig. 26) is threaded through the instrument until the wire is brought well into the field of vision. The instrument with the wire in view is then withdrawn until the latter comes in contact with the prostatic intrusion, when, if it be a small trabeculated outgrowth, the offending mass may be destroyed at 1 or, at the most, 2 sittings. If, however, it be a uniform elevation, a series of linear cauterizations may be executed from one side to the other. This results, when the treatment is completed, in a series of radiating incisions on the floor of the sphincter, about 6 or 8 in number. It is best to be conservative with the first treatment, noting carefully the reaction and the effects of the same. The second treatment should not be undertaken until the increased frequency and bladder discomfort resulting from the previous treatment have disappeared. For ordinary use the Oudin or monopolar current is employed. The D'Arsonval or bipolar current has, however, found considerable favor at the hands of some operators.

Finally, indiscriminate use or improper selection of cases is not unattended with risk. Emphasis is laid upon the great importance of early diagnosis, years earlier than at present. The diagnosis must be made before profound structural secondary changes have taken place. The cases limited to this type of treatment are those suffering from constriction of the vesical neck, median bars or lobes, and single lobe projecting into the bladder or urethra from any portion of the prostate. (See Fulguration.)

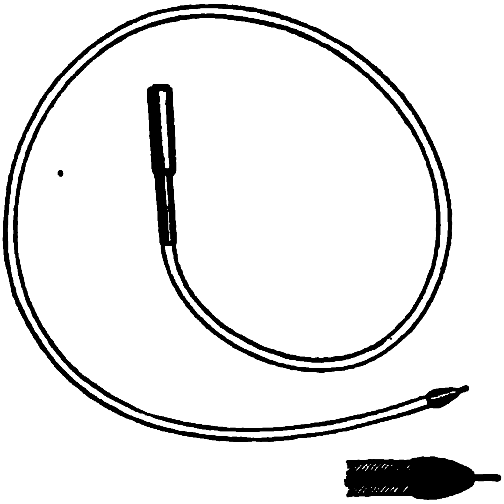

FIG. 26.—SQUIER-MCCARTHY ELECTRODE FOR FULGURATION

INTRA-URETHRAL CUTTING OPERATION

Young's Punch Operation.—DESCRIPTION OF INSTRUMENT.—The instrument employed in Young's punch operation consists of an outer tube about 18 cm. long, with a coude curve at its inner end and an urethroscopic disk at the other, containing a post on which an external urethroscopic light can be attached (Fig. 27). Near the inner end on the under surface a large fenestra is provided. Within the instrument is a second tube which has a sharp cutting

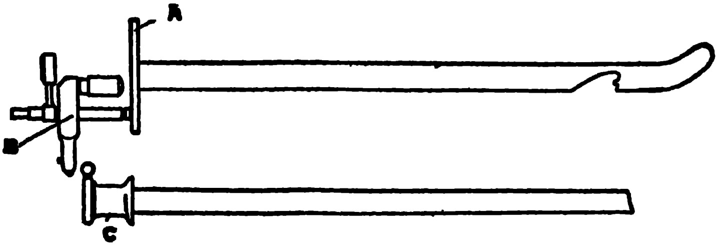

FIG. 27.—YOUNG'S PROSTATE PUNCH. A, Outer tube; B, endoscopic lamp; C, cutting obturator.

inner end made of steel, which, when pushed forth, can excise anything appearing inside of the outer tube. The object of this instrument is, when it is pushed through the urethra into the bladder, to engage the median bar in the fenestra and then to excise it by means of the inner cutting tube, while observing the operation through the inner tube illumined with the external urethroscopic lamp. (Young's description.)

TECHNIC.—The instrument is inserted, with the cutting obturator pushed forward until the end of the instrument is found to enter the vesical orifice. The inner tube is then withdrawn about 2 cm., the electric light attached externally, and an inspection made. As a rule, the verumontanum will be seen bulging into the fenestra. The instrument is then pushed slowly inward, the verumontanum is seen to disappear, and the median portion of the prostate gradually enters and finally fills the fenestra completely. If the instrument is pushed a little further inward, urine escapes, assuring the operator that the instrument is in the bladder. When it is drawn outward the flow of urine ceases, showing that the inner edge of the fenestra is caught against the median bar, a good view of which is easily obtained after aspirating the fluid from the interior and drying with swabs (Fig. 28). The inner cutting tube is then rapidly pushed forward and excises in 1 piece the tissue caught in the fenestra. With rongeur forceps inserted into the instrument, this piece of tissue is removed and is usually 1.2 to 1.5 cm. long, a third of its circumference being covered with mucous membrane partly vesical and partly urethral. Experience has shown that 1 cut is usually not sufficient, and that it is wise next to turn the instrument first to the right and then to the left in order to remove more of the median bar on each side. The lateral cuts never excise as much as the posterior medium, generally about a third as much. The cutting tube is then removed; the bladder is washed out through the outer tube, and when it is apparently clear of pus, the obturator is introduced and the instrument withdrawn. Immediately afterward a 2-way urethral rubber or gum catheter is inserted into the bladder and continuous irrigation at once begun. If clots are present, they are evacuated by means of a large hand syringe, but generally this is not necessary.

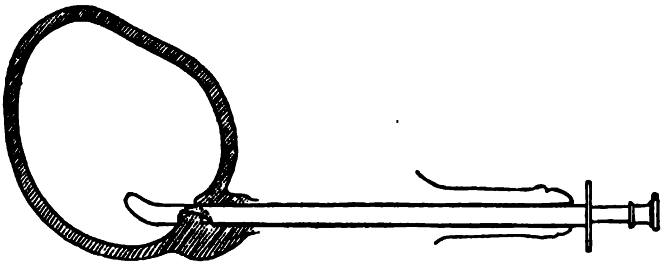

FIG. 28.—PROSTATE PUNCH IN PLACE. Median bar about to be excised.

After the double catheter has been fastened in place by means of adhesive strips around the penis, the patient is returned to the ward, where continuous irrigation of the bladder is at once resumed. This irrigation is kept up for 24 or 48 hours. The patients are able to leave the hospital in 2 or 3 days and, as a rule, are able to void urine with much greater freedom at once and the convalescence is generally rapid and satisfactory, no treatment other than urotropin and water in abundance being required. The use of sound or dilator after the operation is unnecessary. Young's conclusions in regard to the use of this instrument are as follows:

"Over one hundred patients have been operated upon without mortality. The majority were performed under local urethral anesthesia, 4 per cent. novocain being used. After evacuation of the pus through the instrument at the time of operation, a large 2-wayed catheter usually takes care of any hemorrhage which may occur, if immediately connected with continuous irrigation. It is often necessary, however, to use a large syringe to dislodge or aspirate any obstructing clots, since during the first 24 hours their presence may cause painful vesical spasms." He warns against the operation being performed without the patient being under careful observation by trained nurses and hospital attendants. "In 2 cases a subsequent suprapubic cystotomy for drainage and removal of blood clots was found to be necessary, upon a patient who had been operated upon by a physician who was not equipped with the proper 2-wayed catheter and evacuating apparatus. The types of lesions most amenable to this form of intra-urethral operation may be arranged in 3 groups, those in which a dense layer of new formed connective tissue, immediately beneath the mucous membrane, has formed a firm fibrous ring associated with elevation of the median portion of the prostate, a second type in which in addition to submucous connective tissue layer, there was found a chronic inflammatory condition of the gland tissue, often with soft periacinous fibrous infiltration, occasionally extending into the muscle; third, a type of lesion in which there was a definite hypertrophy of the submucous gland tissue, involving either the suburethral or subtrigonal groups of glands or both."

Goldschmidt Endoscopic Prostatotomy.—An instrument, similar in purpose but rather more complicated, has been devised by Goldschmidt and is known as the Goldschmidt operating endoscope. By means of this instrument prostatic bars may be incised or excised, or lobulated outgrowths of the vesical neck or deep urethra may be removed, and various minor surgical procedures performed within the urethra. For a detailed description, the reader is referred to Endoscopy, which is treated elsewhere in this work. The instrument is much more complicated than seems necessary and has no advantage over the methods already described.

INFRAPUBIC PROSTATECTOMY AND CYSTOTOMY

L. Heusner describes, under the above heading, an operation for the removal of the prostate and lower part of the bladder by an exposure immediately under the pubic bone. He claims for this method more direct access to the prostate and better drainage of the bladder than when the operation is performed through the suprapubic route.

Technic.—STEP 1.—Make a curved incision through the skin along the lower margin of the pubis and the descending rami.

STEP 2.—Divide the insertion of the suspensory ligament of the penis, the corpora cavernosa, the ischiocavernous muscle, the triangular ligament, and part of the insertion of the abductor muscle of thigh.

With a chisel or rongeur forceps cut away about half of the symphysis pubis from the descending rami. When this is done, it is easy to pull the prostate downward and expose its full anterior surface. Bleeding from the plexus of veins anterior to the prostate is liable to be considerable. If this cannot be sufficiently controlled to permit of further progress, or if, as in Heusner's case, the patient is too weak, it is easy to pack the wound and resume the operation after the lapse of a few days.

STEP 3.—Pass a sound into the bladder through the urethra. Using the sound as a guide, split the prostatic urethra through its whole extent along its anterior or vesical surface. This exposes the prostate exactly as in a post mortem.

STEP 4.—Remove all obstructing lobes exactly as is done when other methods of exposure are employed. If it is desired to open the bladder instead of the prostate, this is easily accomplished by the removal of more bone from the pubis. The operation is, however, much more suitable for prostatic than vesicular disease.

STEP 5.—Close the wound in the prostate with a few catgut sutures. Provide for drainage. Close the skin wound.

OPERATION FOR RELIEF OF SUPPURATION

Perineal Drainage.—Relief of suppuration within the prostate gland may be accomplished either through a median perineal incision or a transverse perineal dissection; the technic varies in no way from the technic for exposure of the prostate for removal, as already described.

There is, however, in my judgment, a distinct choice between these 2 methods. I believe that prostatic abscess may be more completely evacuated by an incision into the lobe over the surface of the prostate than by evacuating it in through a cut into the urethra. The open dissection of the transverse perineal operation gives better drainage than the median operation and is in every way to be preferred.

The old idea of rupturing a prostatic abscess into the bladder or urethra by means of a sound passed into the urethra is absolutely faulty technic. If the deep urethra of a patient, who has been subjected to such treatment, is examined with an endoscope after the abscess is supposed to be healed, deep diverticula are found connecting with the prostatic urethra which tend to harbor infection indefinitely and it is questionable if they can ever be rendered sterile by intra-urethral treatment.

Alexander, in years gone by, appreciated this fact, and went so far as to recommend the removal of all prostatic tissue possible at the time of operation for evacuation of the abscess.

This advice should not be followed, on account of the danger of producing permanent urinary incontinence, since the acute inflammation present destroys the proper lines of cleavage and a complete prostatic removal at such a time will undoubtedly destroy the external sphincter of the bladder.

OPERATION FOR THE RELIEF OF MALIGNANCY

Prostatectomy.—In considering removal of the prostate for carcinoma, one has, as with benign hypertrophic change, the choice of perineal and suprapubic approach. There seems to be very definite histologic reasons why the perineal approach is preferable in most instances, when the prostate alone is invaded by this disease. Quite a different problem is presented than if we were dealing with benign adenomata, since, in the latter instance, the aim of the operation would be to remove the adenomatous overgrowth through a line of cleavage of compressed prostatic tissue. In dealing with prostatic cancer, however, as it is important to remove every vestige of prostatic tissue, perineal exposure offers the best approach to make this possible.

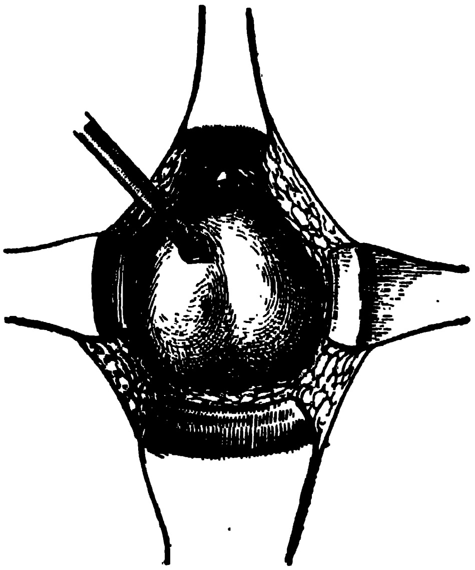

FIG. 29.—URETHRA DIVIDED AND PROSTATE PULLED DOWNWARD. (After Young.)

If we believe that the posterior lobe of the prostate is the one most usually first involved, the impression might be gained that, as from 10 to 20 per cent. of cases of prostatic obstruction are of carcinomatous character, the perineal exposure would always be the ideal method for removal of the gland. The point, however, is just this: In the ideal perineal prostatectomy for benign hypertrophy an attempt is made to conserve this posterior lobe and not to destroy it, on account of its close association with the urethra in the neighborhood of the colliculus; and also because it acts as a covering to the ejaculatory ducts. The best description of the perineal operation for radical removal of the prostate for cancer is that of Young (7).

The operation is only suited to cases in which the disease is well limited to the prostate or does not extend more than a short distance beneath the trigone.

TECHNIC.—The first steps of the operation are similar to those of prostatectomy through lateral capsular cuts by transverse perineal incision already described.

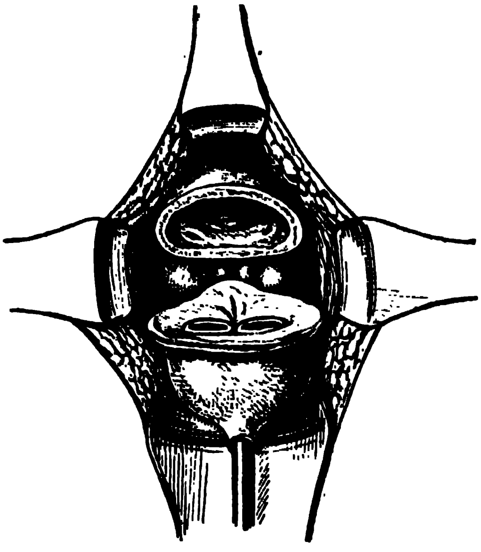

FIG. 30.—EXCISION OF BLADDER NECK AND PROSTATE.

The prostatic tractor being in place, and the posterior surface of the prostate having been exposed, if there is any doubt as to the diagnosis, incise the capsule and remove a piece of the gland for immediate microscopic section.

The lateral adhesions of the prostate and also the seminal vesicles are freed, and the membranous urethra completely divided in front of the tractor (Fig. 29). The prostate and neck of the bladder are now pulled downward and the puboprostatic ligament divided close to the prostate after pushing away the anterior plexus of veins. Further pulling down exposes the anterior wall of the bladder. The bladder is opened by a transverse incision close to its junction with the prostate (Fig. 30). Next the transverse cut in the bladder is carried across the trigone, leaving the upper angles of the trigone intact and the ureters undisturbed. By a blunt dissection through the wound in the bladder complete the exposure of the seminal vesicles, pick up the vasa deferentia, and divide them as high as possible. Remember that the vasa deferentia are situated around the lower end of the ureters and these must not be injured. Then separate the deep attachment of the seminal vesicles, securing the resulting bleeding points by clamps or ligatures. Remove the prostate, seminal vesicles, and about 5 cm. of the vasa deferentia in 1 piece. Pull the anterior walls of the bladder down and form an anastomosis between the anterior part of the bladder wound and the divided membranous urethra, using catgut for sutures (Fig. 31). Close the rest of the vesical wound by catgut sutures. Introduce through the penis a retention catheter. Approximate the levator ani muscle with catgut sutures and properly close the skin wound after providing for drainage.

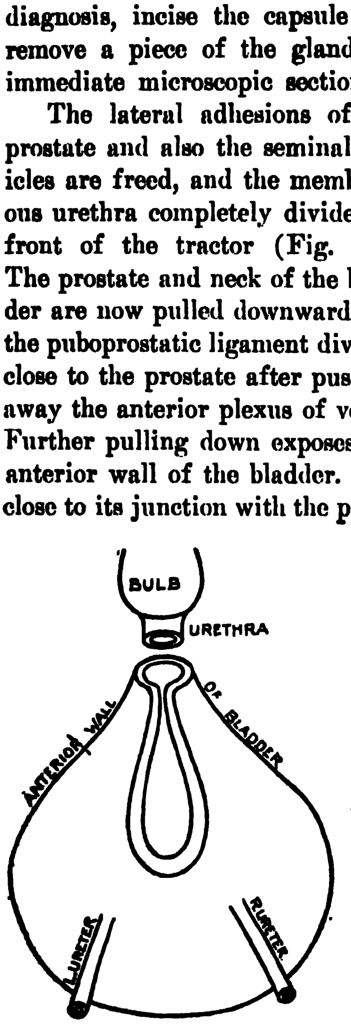

FIG. 31.—REPAIR OF BLADDER NECK AND ANASTOMOSIS WITH DIVIDED URETHRA.

COMMENT.—Suprapubic approach to a vesical and prostatic carcinoma will be of service only as a palliative operation to remove a certain portion of carcinoma which may be obstructing the vesical neck or to afford suprapubic drainage. For further consideration of carcinoma in this locality the reader is referred to the chapter upon Surgery of the Bladder (Vol. IV, Chap. I).

Fulguration.—Fulguration in prostatic carcinoma has been of but little benefit. In such cases, however, as those developing profuse hemorrhage, some surgeons claim to have been able to control the hemorrhage by application of the high-frequency current. From my own experience, however, I believe it to be of but occasional use.

In 1912 I carried on some experimental work in an effort to study the action of electrical cauterization on neoplasms. The research was conducted at the Laboratory of Dr. Francis Carter Wood, Director of the Crocker Cancer Research. As it has a direct bearing upon the effects which high-frequency cauterization may be expected to exert upon carcinoma in any location, a brief résumé of the findings may be of interest in this connection. Tumor-bearing large white rats that had been inoculated subcutaneously with either a carcinoma of high virulence or a sarcoma were used as material for experimentation. These tumors, as the result of repeated transfers, were so virulent that practically all of the inoculations were successful. The first series of experiments was carried out upon animals in whom the growth was in the subcutaneous tissue of the abdominal wall. The tumors were thoroughly fulgurated with bipolar electrodes, the distance between the poles being the diameter of the tumor. The current burned holes in the skin, and the tumors were loosened from surrounding tissue and fell out. The tumor material, when examined microscopically, did not show any evidence of extensive alteration; the staining qualities of the cells were merely somewhat less marked than in normal tissues. The deduction from this was that the cells were not much burned. Remnants of the neoplasm could be found at the site of the tumor. All of the animals died, and death was not due to the extension of the tumor. The lesions found were those of an acute enterocolitis resembling that found after severe and extensive burns.

In a second series the animals were inoculated with carcinoma. Some of the animals died immediately after the cessation of the application of the current. In the ones who survived the operation the infected surfaces of the granulating tumors had become clean, though the tumors were extending in growth. From a very considerable number of experiments the following deductions were made. First, that the current is not entirely a harmless agent; second, that it does not actually char the tissues very extensively; third, that it does not effect extensions outside the field of the main growth; fourth, its action is simply that of an easily handled cautery.

This concludes the present-day operative measures which may be employed in dealing with the various forms of prostatic disease. The dangers and difficulties of these various operations will next be outlined.

DANGERS AND DIFFICULTIES OF PROSTATIC SURGERY AND CAUSES OF FAILURE

CAUSES OF FAILURE

The following factors may interfere with success in the restoration of function by operation: (1) Incomplete removal of the obstruction; (2) the introduction of some other form of obstruction as a sequel of the operation itself; (3) loss of voluntary control of urination; (4) injury to the rectum; (5) persistent urinary fistula; (6) failure to recognize complicating conditions, such as vesical calculus, etc.; (7) loss of sexual or procreative power.

Incomplete Removal of the Obstruction.—The consensus of opinion of all authors seems to be that a return of obstructive symptoms due to incomplete prostatic removal is most apt to follow perineal prostatectomy. The likelihood of this recurrence is remote if enucleation has been properly carried out, whether the operation is done by suprapubic or perineal approach.

That secondary operations for the removal of re-formed or overlooked prostatic outgrowths following perineal operation are not uncommon, may be best appreciated by a careful perusal of the various reports upon punch operations and intra-urethral prostatic removals. Among the reported statistics we find that many of these cases have been subjected to a preliminary or previous prostatectomy without complete relief, which the secondary operation afforded them.

The Introduction of Some Other Sort of Obstruction as a Sequel to the Operation.—Scattered through the literature on prostatectomy, a few reported cases of stenosis of the vesical outlet following operation will be found. Some writers merely allude to the desirability of an occasional passage of a sound to guard against possible stricture formation, and others regard this as an unnecessary precaution. That it is more likely to occur following perineal than suprapubic operation is obvious. In the suprapubic operation all the operative work is carried out behind the posterior layer of the triangular ligament; therefore, stricture formation in the urethra is almost out of the question. When it occurs in the prostatic urethra, it usually follows an operation undertaken for the relief of an obstruction due to a fibrous collar surrounding the vesical neck. I have seen a number of such cases which required secondary operation for relief.

Loss of Voluntary Control of the Bladder.—Loss of voluntary control following prostatectomy seems, next to death, the most tragic result. The patient is often in a much more deplorable state from incontinence than he ever would have been from retention. And it is questionable if a patient had to decide between the permanent use of a catheter or the permanent wearing of a urinal, whether he would not resign himself to the increased mortality risk of the catheter rather than accept operation. The question of postoperative incontinence of urine depends absolutely upon the preservation of the integrity of the compressor urethræ muscle. In the suprapubic operation, this muscle being outside the field of operation, injury to it is a gross lapse of technic. With the perineal operation, however, a careless or faulty dissection of the perineum may produce injury of the muscle itself or interfere with its enervation to such an extent that its functionating powers are destroyed. This is one of the strongest arguments which the exponents of suprapubic prostatectomy have as a justification for the acceptance of their teachings.

Injury to the Rectum.—In the hands of a skilled surgeon, injury to the rectum should never occur, and it is only with the perineal operation that danger to it has to be considered.

Injury to the rectum usually occurs in a surgeon's early experience, but if the operator thoroughly familiarizes himself with the dissection of the perineum and appreciates the importance of using gentleness and care in dissecting the rectum free from the base of the prostate, it is a simple matter to avoid this complication. If, however, in spite of all precautions, the rectum is torn into during the course of perineal prostatectomy, the rent should be immediately repaired. Do not make the mistake of trusting to nature to repair it by granulation, because a recto-urethral fistula will always result. A point or so in the repair of such a rent may be pertinent: A purse-string suture of catgut is inserted to encircle the torn opening and upon tightening this suture the gap is closed, attention being directed to cause the torn edges of mucous membrane to project into the lumen of the rectum. Over this purse-string suture the muscular wall of the rectum is brought together by a series of Lembert sutures. A final precaution, which should never be omitted, is the full dilatation of the sphincter ani muscle after the completion of the prostatectomy.

Persistent Urinary Fistula.—A slow-healing urinary fistula may occur after either perineal or suprapubic prostatectomy. The method which ensures against its occurrence following suprapubic operation has already been referred to in the description of the author's operative technic. The persistence of urinary fistula is, as a rule, whether perineal or suprapubic, due largely to the fact that an obstinate cystitis is present. Treatment directed toward clearing up this cystitis will have a salutary effect upon the rapidity of healing of the fistula. In cases of long-standing perineal fistulæ, operation offers the only cure, the operation being a dissection and excision of the fistulous tract with subsequent drainage of the bladder by means of an indwelling catheter.

Failure to Recognize Complicating Conditions.—Under this heading I would place failure to recognize the presence of small calculi in the bladder and the presence of diverticula as among the most important. A thorough search of the bladder with the finger should never be omitted at time of operation for fear of overlooking some small fragment of stone. In regard to diverticula, a different situation obtains. In a collapsed bladder it may be well-nigh impossible to locate them merely by digital examination. This at once brings up the question of the advisability of cystoscopy prior to prostatectomy. By cystoscopy one can at least be suspicious of the presence of diverticula by the appearance of their characteristic openings. In my judgment, a carefully performed cystoscopy should never be omitted prior to operation, not only on account of the information which one derives concerning intravesical complications, but also on account of the knowledge which may be gained concerning the configuration of the intravesical portion of the prostate. Such information will materially aid in determining which is the proper type of operation to be performed to relieve the particular form of obstruction. While the knowledge of a diverticulum being present in the bladder may not alter our judgment as to the advisability of operation, it should make us a little cautious in regard to the ultimate prognosis as to the degree of restitution of urinary function which we give our patients. The presence of a diverticulum of any considerable size may be the determining factor against clearing up a chronic cystitis or a recurrent calculus formation in the bladder; and the patient may, therefore, be quite as uncomfortable postoperatively, from the complications produced by a diverticulum, as prior to the operation, even though the obstruction to urination has been removed.

Loss of Sexual or Procreative Power.—At the present stage of our knowledge, we believe that suprapubic operation carries with it less liability of permanent injury resulting to the ejaculatory ducts than the average perineal operation. Fortunately, in most of our patients this is a question of but small moment, but in those patients whose prostatic symptoms develop in the early fifties it may assume a position of importance. Another difficulty is that the type of urinary obstruction usually met with at this age is a small prostate, a contracture of the vesical neck or a bar formation. As we have already stated, these are the cases which are best handled by some intra-urethral procedure or by perineal operation. For this reason, the ejaculatory ducts are more liable to be injured, either by inflammatory stenosis following intra-urethral procedure or by faulty technic of the perineal operation. It, therefore, behooves us to advocate that method of perineal exposure in which a definite attempt is made toward their conservation. Regarding sexual vigor, it may be well increased after suprapubic prostatectomy, the reason for it being the relief which results from the removal of pressure on the seminal ducts following the operation.

Vesical Atony.—Freyer claims that residual urine should never be present after prostatectomy, provided the prostate has been properly removed, and that, no matter how long or how great the overdistention of the bladder has been before operation, with the obstruction removed it will empty itself absolutely. The theory of this may be correct, but, practically, many bladders whose muscles have become degenerated from long overdistention require months of time and much treatment before an approximation of their normal vigor is regained—sometimes it never is. Whether there is or is not such a condition as permanent atony is still an open question. Some believe in the existence of vesical atony and dilatation of the upper urinary tract without the presence of obstructive factors or nervous disease. For this reason exhaustive differential diagnosis should be resorted to before operation is considered in those cases where there is the slightest doubt as to the prostate forming the obstructive factor.

DANGERS OF PROSTATECTOMY

The chief dangers of prostatectomy are: (1) shock; (2) hemorrhage; (3) uremia; (4) septicemia; (5) bronchitis and pneumonia; (6) cerebral hemorrhage and thrombosis; (7) pulmonary embolism.

Shock.—The possibility of shock following an operation for removal of the prostate can be materially lessened by careful preparation of the patient before operation, by wise selection of the anesthetic, by rapid operation and attention to the details of operative technic, as already outlined. The mortality of the operation from shock is almost negligible. A number of elements beside the operation itself enter into the production of shock. The physical state of the patient prior to the administration of the anesthetic is a factor. Everything possible should be done toward eliminating any terror which the patient may have of operation. A quieting injection of morphin and scopolamin an hour before operation aids greatly in helping the patient to approach operation in a tranquil frame of mind. All time-consuming details, such as filling the bladder, sterilizing the skin, arrangement of towels and sterile sheets on the patient, should be performed before the anesthesia is commenced.

Hemorrhage.—The various methods to be employed for controlling hemorrhage at time of operation have already been outlined under operative technic. It is the custom with many surgeons to use continuous irrigation of the bladder following operation. I believe that such continuous irrigation may so mask the actual amount of hemorrhage which a patient may have that it is unwise to employ it. It seems safer to allow clots to form and thus check oozing, rather than to take the risk of dislodging them and exciting prolonged bleeding by constant irrigation. Secondary hemorrhage may take place a week or 10 days after operation, and it is usually due to sepsis or to over-exertion on the part of the patient. In regard to the treatment of secondary hemorrhage, should it occur, if flushing of the bladder with hot saline solution does not immediately check the bleeding, no time should be wasted but the patient should immediately be placed under an anesthetic and the prostatic cavity thoroughly packed and a drainage tube re-inserted into the wound. This applies equally whether the operation has been performed perineally or suprapubically.

Uremia.—The occurrence of postoperative uremia usually indicates that the patient has not received careful preparation before operation. The cases who die from anuria, as a rule, belong to that class of prostatiques suffering from overdistended bladder and in whom no infection of the bladder had taken place. Such a patient, in my judgment, is always the poorest operative risk, and requires a more prolonged preparatory treatment before operation is undertaken. The anuria is usually produced by a nephritis plus sepsis, and it is usually found that in patients in whom a mild degree of cystitis has existed for some time, an acquired immunity to the effects of infection has resulted, and, as a rule, they do better after operation than those in whom the bladder is absolutely sterile.

Patients who have not acquired such immunity before operation, and who are in addition suffering from renal disease, are more apt to develop acute exacerbations of the disease when postoperative septic absorption takes place. Two conditions are probably responsible for any preëxisting immunity to the dangers of postoperative absorption, namely, the blocking of the lymphatics by a long-continued cystitis and the production of antibodies within the individual.

Bronchitis and Pneumonia.—In operating upon patients suffering from chronic bronchitis the question of choice of anesthetic is all-important, spinal anesthesia being unquestionably the anesthetic of election.

Cerebral Hemorrhage, Thrombosis, Pulmonary Embolism.—In guarding against the possible occurrence of these postoperative complications, the following warning is given: Two of my patients who succumbed to embolism had had indwelling catheters inserted shortly after operation in an effort to expedite wound healing. In both instances the catheters were not well tolerated and induced very considerable vesical spasm. I believe that during the straining produced by these spasms, clots were forced out of the pelvic veins into the general circulation, with consequent death. For these reasons it seems that the use of the indwelling catheter immediately after operation should not be instituted until sufficient time has elapsed for the blood-clots in the vessels to become well organized. This argument also applies to the question of immediate closure of the bladder and suprapubic wound in an effort to obtain primary union, draining by the use of indwelling catheters only. Although it is occasionally possible to obtain primary union by such a procedure, the added postoperative danger produced by an indwelling catheter inserted at an early period is scarcely justified.

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OPERATIONS UPON THE URINARY BLADDER

CHAPTER XV

OPERATIONS UPON THE URINARY BLADDER

J. BENTLEY SQUIER

GENERAL CONSIDERATIONS

The surgical approach to the bladder is by way of a suprapubic incision or a perineal section. Either one of these procedures is a preliminary step to all vesical operations. Operations upon the bladder are designed to meet 4 main surgical indications.

A. Operations to institute vesical drainage.
B. Operations upon intra- or extravesical lesions.
C. Operations for excision, resection, or plastic repair of the bladder.
D. Operations for the correction of associated or secondary vesical conditions.

The institution of bladder drainage is by far the most common operative procedure, and urinary retention is the most frequent condition necessitating it. Vesical drainage is necessary as a means of relieving retention due to, or associated with, stricture, hypertrophic prostate, contracture of the vesical neck, malignancy, and acute inflammatory conditions of the prostate and rectum. In infective conditions incident to the presence of calculi, acute cystitis, trigonitis, and malignant neoplasms the institution of temporary or permanent drainage is the essential element in the operative procedure.

In the mildest forms of urinary retention simple catheterization will be the only procedure indicated, while in the true organic occlusive processes in the neighborhood of the internal urinary meatus a more extended operation will be demanded. The simplest operation for drainage of the bladder is paracentesis vesicæ, and the most thorough and efficient, either the suprapubic or perineal cystotomy.

Suprapubic cystotomy is an operation in itself, but is, in addition, the first step in all operations making a suprapubic approach to the interior of the bladder. It offers a means of thorough exploration of the bladder and is the best exposure for any intravesical pathology. In cystorrhaphy of the bladder for rupture, whether the rent is intraperitoneal or extraperitoneal, a primary cystotomy is essential for proper orientation and repair, as well as for the establishment of drainage. In suprapubic prostatectomy the approach for intraurethral enucleation and subsequent drainage is by way of a suprapubic cystotomy. In some cases of contracture of the vesical neck divulsion or division of the anomalous constriction is best obtained by this means. Retrograde catheterization is a rare indication for suprapubic cystotomy.

Under extirpative operations, cystectomy, either partial or complete, embraces 3 distinct surgical conditions: neoplasms, diverticula, and cysts. For practical purposes all vesical neoplasms, even when histologically benign, may be considered potentially malignant on account of the very marked tendency for benign tumors to undergo a malignant change. A tumor may be benign on excision and upon incomplete extirpation recur as a malignant tumor. It may be stated that if any operative treatment is undertaken for the extirpation of vesical tumors, the correct surgical dictum is that all operative vesical tumors should be considered malignant. Albarran's statement (1) that "all vesical tumors are malignant or likely to become so" is essentially correct. In substance, then, cystectomy is to be considered radical where efforts at cure are attempted. Increasing experience emphasizes the fact that any measures short of radical through extirpation are both futile and unwarranted. The operative procedure must be a measure that will remove the tumor en masse with or without the aid of actual cauterization. Anything in the nature of a palliative operation for tumors of the bladder will be only a drainage operation or cystostomy. In benign papillomata the intravesical application of the Oudin high-frequency current has given better results than the simple suprapubic excision.

Diverticula demand special treatment and the application of modified forms of technic, depending upon their size, disposition, and associated anatomical topography. Plastic resection in some form or other will be in many cases the only technic applicable, while complete excision will be the operation of election where possible. Rarely there may be cysts within the bladder or connected with its wall, such as implantation hydatid cysts. The treatment of this rare condition will demand the application of a special form of surgical technic depending upon the vesical or peritoneal attachment of the cyst, and may necessitate either an intraperitoneal or extraperitoneal operation or a combination of both methods.

The surgical treatment of the associated conditions, such as hernia of the bladder, cystocele, vesicovaginal fistula, etc., is considered under their respective chapters.

GENERAL ANATOMY

The bladder, being a hollow muscular organ with alternate periods of distention and contraction, is subject to considerable variation in shape, position, and peritoneal reflection. The disposition of the peritoneum under natural and artificial conditions of retention and distention is the main surgical consideration, for upon the mobilization of the peritoneum under various conditions of distention are founded all of the suprapubic extraperitoneal operative procedures. In an adult, under normal conditions, the bladder is in the anterior portion of the true pelvis and the apex or summit with its serous covering is just behind or just below the superior margin of the symphysis. In children the bladder is partially an abdominal organ, and the apex is about 2.5 cm. above the level of the superior border of the symphysis. As the bladder becomes distended, the shape becomes more nearly oval, and the apex rises out of the pelvis into the abdominal cavity. Coincidentally, the peritoneum is elevated and draws away from the lower abdominal wall, leaving the lower half of the superior surface of the bladder immediately above the symphysis without intervening peritoneum. The extent of the peritoneal separation is directly proportionate to the degree of distention, for when the summit of the bladder is midway between the navel and the symphysis there is exposed about 5 to 7 cm. of free non-peritonized bladder surface. The amount of fluid necessary to bring this about is roughly 600 c. c.

Extending from the apex to the navel is a fibrous band, covered on its under surface by the peritoneum and known as the urachus. It is a definite landmark and offers a ready means of identifying the summit of the bladder. The presence of the urachus prevents the bladder from descending much below the superior level of the symphysis. Upon division of the urachus, the bladder, incased as it is in loose connective-tissue reticulum, is capable of extensive operative mobilization. From the navel on each side of the urachus there arise 2 fibrous bands, representing the obliterated hypogastric arteries, which pass downward as divergent cords to the lateral walls of the pelvis. In the adult male the peritoneum extends down from the summit of the bladder into the rectovesical pouch and extends over the superior aspects of the seminal vesicles, vasa deferentia, and lower ureters to be reflected upon the rectum. In the adult female the peritoneum extends from the summit of the bladder to about the level of the internal os and is then reflected over to the anterior surface of the uterus.

The relation of the vas deferens to the ureter is a valuable landmark in the surgical topography of the base of the bladder, for it offers the best means of readily and easily locating the terminal ureter. The ureters, under ordinary conditions, are firmly fixed to the peritoneum, and they enter the postero-inferior surface of the bladder about 2 cm. from the mesial plane. The vas deferens runs backward and inward, extraperitoneally, to enter the true pelvis, and is continued from before backward and from above downward and inward, to the inner side of the seminal vesicles. It passes the obliterated hypogastric artery on its inner side, and about 7 cm. lower down is crossed by the ureter, just as the ureter enters the bladder. The ureter then is posterior and external to the vas deferens (Fig. 1).

The prevesical space of Retzius is the area between the peritoneal reflection and the superior margin of the symphysis and lies anterior to the bladder and posterior to the symphysis. It is filled by a loose connective-tissue reticulum and lobules of fat and communicates laterally with the general extraperitoneal space.

The base of the bladder is bounded by 3 natural orifices which form an equilateral triangle, 2.5 cm. to the side. Between the 2 ureteral orifices is a bridge of tissue, the so-called interureteric ligament. Immediately posterior to this is the basal prostatic pouch or bas-fond. The base of the bladder is firmly attached to the rectum in the male and to the anterior wall of the vagina and cervix in the female. It is covered by thin, non-rugated mucous membrane, much more vascular than the adjacent bladder mucosa.

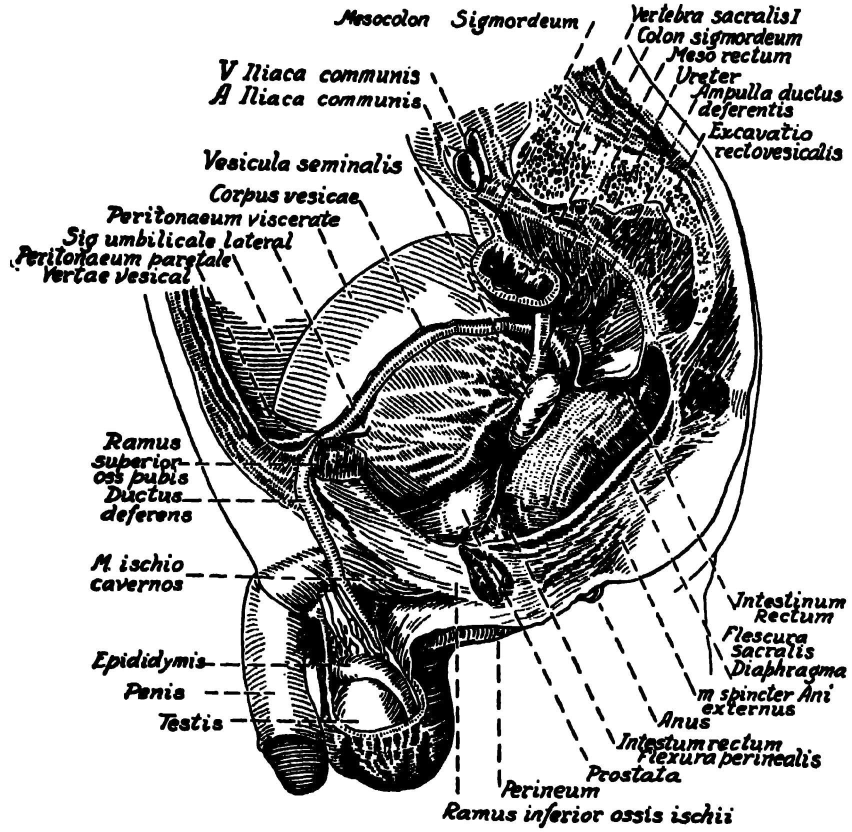

FIG. 1.—MALE PELVIC ORGANS AFTER REMOVAL OF THE LEFT PELVIC WALL, SHOWING THE RELATION OF THE TERMINAL URETER TO VAS DEFERENS AND SEMINAL VESICLE. The urinary bladder moderately distended. (After Spalteholz.)

The internal urinary meatus is downward and backward about 2.5 cm. from the posterior surface of the symphysis and about 5 to 6.5 cm. from the perineum. The meatus and the base of the bladder are practically fixed points, regardless of changes in the shape of the bladder from distention. The base of the bladder may be raised to a slight extent by distending the rectum with free fluid or by means of a dilating bag with a capacity of 250 to 300 c. c. Although the base may be thus elevated to a very slight extent, there is no corresponding elevation of the superior surface of the bladder. A Trendelenburg position, however, will allow the intestines to gravitate toward the upper abdomen and bring about an elevation of the superior vesical surface, thus exposing about 5 cm. of non-peritonized bladder and allowing a suprapubic cystotomy to be accomplished without difficulty.

The anterior fixation of the bladder is by means of the puboprostatic ligaments, 1 on each side of the mesial plane. They spring from the posterior surface of the pubes and pass directly back and downward to become attached to the bladder and prostate. All operative procedures on the bladder should preserve this pubovesical attachment, as an impairment of its anatomical integrity results in delayed healing and increased opportunity for infection.

PREPARATION FOR OPERATION

The preparation of a patient for operation embraces: preparation of the patient himself, preparation of the field of operation, and anesthesia.

a. Preparation of the Patient.—The preparation of the patient will depend upon the primary operative indication. If it is a case of acute retention, no preliminary preparation of the patient is possible, as the operation is usually an emergency procedure and the pathological condition acts as a bar to pre-operative bladder lavage. In other cases, when time of operation is not imperative and there is no obstruction, or a cystitis is present without bleeding, the degree of sepsis may be very markedly diminished by a preliminary course of catheterizations with bladder lavage. The bladder is catheterized every 4 hours and washed out with a saturated solution of boric acid, while urotropin 0.50 gm., every 4 hours is usually administered by mouth. The action of the urotropin is greatly enhanced by the addition of sodium benzoate 0.50 gm. every 4 hours.

The blood-pressure is taken, the cardiovascular system inquired into, and such stimulants as may be necessary are given. The index of renal elimination is determined by the phthalein test and a 24-hour urinary specimen examined. **Twenty-four hours previous to operation the patient is given a cathartic. My own choice is castor oil, 30 to 50 c. c., as it produces a complete evacuation of the bowels without a secondary distention.** In the morning of the day of operation 1 or 2 enemata of about 500 c. c., usually of soapsuds, are given in order to cleanse the lower bowel. The patient is allowed fluids up to 1 hour previous to operation. If the patient shows a degree of desiccation or an apparent lack of fluids, he is given 1,000 c. c. of the following solution by proctoclysis: normal saline, 1,000 c. c.; whiskey, 15 to 30 c. c.; strychnin sulphate, .004 gm.

Preparation of the Field of Operation.—Time permitting, the abdomen is shaved the night before the operation and no further preparation of the operative field takes place until the patient is upon the table. When the case is urgent, the patient is shaved without the addition of water, usually using alcohol as a fluid medium for the shaving. Upon the operating table the abdomen is swabbed with a solution consisting of crystal iodin 1 gm., benzin 1,000 c. c., the field wiped dry, and a 3 per cent. tincture of iodin (made fresh weekly) applied. The bladder is distended with saturated solution of boric acid to the extent of 300 to 500 c. c. The catheter may be left in situ, but is usually withdrawn, and tied firmly around the penis to retain the fluid within the bladder during the anesthetization. All of these procedures are carried out before the anesthesia is started.

c. **Anesthesia.**—As a preliminary to operation, the patient is given 1 hour before operation a hypodermic injection consisting of morphin sulphate .015 gm., scopolamin hydrobromid, .0005 gm. For operations of short duration I have found the nitrous-oxid-gas-oxygen sequence very satisfactory. For more prolonged operations I have been better pleased with gas and ether. With either form of anesthesia the technic of anoci-association is an adjunct of value. For a simple suprapubic cystotomy, when the operation is undertaken for stone, pedunculated tumor, or for drainage only, it can be performed painlessly under local anesthesia. I have been in the habit of using the 3 standard solutions of Schleich, and my results have been uniformly satisfactory. Novocain in strengths from ½ to 3 per cent. is also efficient. A number of wheals are produced in the line of the proposed incision with solution No. 1 (Schleich). The subcutaneous tissue and fascial covering are infiltrated with No. 2, while the prevesical space and the wall of the bladder are thoroughly infiltrated with No. 2 or No. 3. If pain is to be obviated, the cutting instruments must be very sharp, the manipulations gentle, and traction avoided.

INSTRUMENTS

The instruments required are: scalpels, 2, full-bellied; scissors, Mayo pattern, straight, curved, blunt, and sharp; thumb forceps, long and short, dissecting, and toothed; retractors, Parker, Fritsch's, large and small, Tuffier's, Balfour's, and flexible; sponge holders, 4, Foerster's, Roosevelt Hospital type; needle holders, 3, 2 Hegar and 1 Richter; Wappler head light; lithotomy forceps; lithotomy scoop; hemostats, 12, Rochester-Kelly, short; 12, Ochsner-Mayo; intestinal forceps, 2 Barrett's, 6 Allis; stone searcher; lithotrite, 3 sizes; aspirators or washing bottles, 3; washing tubes; catheters; metal sounds; irrigating or piston syringe (150-200 c. c.); paracentesis trocar and cannula; record syringe (10 c. c.); Paquelin and galvanocautery; large eye, round point, Mayo or Schroeder tissue needles; Keith triangular point abdominal needles; full curved, cutting edge, surgical needles.

PARACENTESIS VESICÆ

Description.—An emergency or temporary expedient for relieving acute urinary retention. The bladder is entered by means of a trocar and cannula or aspirating syringe immediately above the symphysis.

Technic of Operation.—The diagnosis must be confirmed by percussion and palpation, and the area of urinary distention accurately determined. The point of puncture is in the median line just above the symphysis of the pubes. The cannula should have a caliber about equal to a 20 F. catheter and should have a slight curve. If a syringe is used, a needle of about 14 mm. bore and 10 cm. in length is very satisfactory. The trocar and cannula are grasped in the right hand, with the concavity downward, and the index finger is extended along the shaft of the cannula in order to act as a guard against too deep penetration. The point of puncture is preferably infiltrated with novocain 1 per cent. and the skin nicked with a sharp scalpel and the linea alba steadied by countertraction upward with the left hand. The instrument is plunged downward and backward with a quick wrist movement, perforating the intervening tissue of the prevesical space. The distance of insertion of the instrument will vary with the thickness of the abdominal wall. The trocar is removed and the urine allowed to drain off. After withdrawal of the urine, the cannula may be withdrawn or left for a short time in situ. If the bladder is to be drained in this manner for a few days, a better procedure is to pass a 15 to 18 F. rubber catheter along the cannula into the bladder and withdraw the cannula over the catheter. The catheter is fixed in place by adhesive plaster or a transfixion suture through the skin.

This is an excellent procedure for relieving the bladder of overdistention and maintaining drainage during the subsequent reactive stage of acute vesical congestion. After long-continued retention the withdrawal of urine must not be too rapid in order to avoid hemorrhage into the bladder from acute congestion. Under the circumstances it is wise to leave a small amount of urine in the bladder either by withdrawing the cannula or clamping off the catheter with a hemostat.

Upon removal of the cannula or catheter the wound is sealed with cotton and collodion. This procedure is one of expediency only, and should not be used as an efficient means of drainage. It should not be used at greater length than 3 or 4 days, which is about the limit of toleration by the bladder.

CYSTOTOMY

- a. Suprapubic.
  - I. Longitudinal or vertical incision.
  - II. Transverse or horizontal incision.
- b. Perineal (page 700).

c. Vaginal (page 727).

Cystotomy simply means incision of the bladder. It is necessarily the first step in any operative procedure directed against the bladder. The perineal route per se is more comfortable for the patient. For all other desiderata the suprapubic method is much to be preferred. For vesical calculus in the female, a vaginal cystotomy by incision of the vesicovaginal septum is superior to any other method. (Kelly 14.)

SUPRAPUBIC CYSTOTOMY

Description.—Extraperitoneal incision of the bladder immediately above the symphysis through the prevesical space and below the peritoneal reflection.

Indications.—1. To provide drainage for urinary obstruction incident to hypertrophic prostate, contracture of the vesical neck, stricture, etc.

2. To provide drainage for infective conditions such as cystitis, trigonitis, tuberculosis, malignancy.

3. To remove calculi and foreign bodies.

4. For partial or complete extirpation of vesical neoplasms.

5. To afford a means of visual and digital exploration of the bladder or retrograde catheterization.

6. As a preliminary procedure for cystorrhaphy for rupture of the bladder.

Surgical Landmarks.—The surgical landmarks are as follows: Umbilicus, superior margin of the symphysis, and linea alba.

Longitudinal Incision

Incision.—The incision is made in the median line from the superior margin of the symphysis upward about 7 to 10 cm. The line of incision may be extended upward, toward the navel, as desired or indicated.

Technic of Operation.—STEP 1.—The skin, superficial and deep fascia are divided. The anterior sheath of the left rectus is divided in a longitudinal direction close to the linea alba. The pyramidalis muscle is retracted or cut as it is inserted along the linea alba. The recti muscles are retracted, exposing the semilunar fold of Douglas and the peritoneum with properitoneal fat.

STEP 2.—By means of gauze dissection the peritoneum is gently pushed back and up out of the field. The bladder is readily recognized by the urachal attachment at the apex or summit, by the blue pink color, by the longitudinal muscle fibers, by the fluctuant quality, and by the branched prevesical veins. The surrounding tissues are protected and prolapse of the peritoneal reflection is prevented by adequate walling off with a gauze roll. Some surgeons simply prevent the peritoneum from rolling down by means of a fairly broad retractor and do not wall off the surrounding tissue.

STEP 3.—The bladder may be grasped by 2 single tenacula, or 2 traction sutures may be passed through the muscular coat. The sutures and tenacula are usually placed at the midpoint of the exposed bladder and about 1 cm. from the proposed line of incision. The bladder is opened by a quick thrust, the back of the cutting edge of the scalpel carrying the index finger with it into the bladder. The finger acts as a hook to elevate the bladder and the incision is enlarged downward or upward, as may be desired. **My own preference is to avoid hook and traction ligatures and enter the bladder as indicated.** After the bladder incision is completed (it should be at least 5 cm. in length), the cut edges of the bladder wall are grasped by Allis clamps, 1 on each side. After carrying out the main surgical indication the bladder is closed.

If the cystotomy is performed for calculus and the bladder is reasonably clean and no undue traumatism has been inflicted, the bladder is closed without drainage; if, however, the bladder is infected or has been subject to any undue amount of trauma, or if there is evidence that the bleeding is continuing, or if drainage is demanded per se, the closure must allow for adequate drainage.

The vesical incision is approximated by a Connell suture of No. 2 plain or iodized gut. It is preferable to begin at the lower angle, pass the first stitch, and leave 1 end of the suture long to act as a traction suture.

When no drainage is considered necessary, the incision is closed throughout its length and then reinforced by a Cushing or continuous Lembert suture of No. 1 chromic gut. When drainage is necessary, the drainage tube (Freyer or Marion) is placed at the upper or highest point of the bladder. The tube should have a diameter of at least 1.5 cm. and should be inserted about 3 to 5 cm. within the bladder; it should have an eye 1 cm. from the bladder end, and in no way should the end of the tube impinge upon the base of the bladder. A transfixion suture of plain gut No. 2 is passed through the bladder wall and anchors the tube to the upper angle of the vesical incision. A purse-string suture of No. 2 plain or iodized gut should encircle the tube and approximate the vesical tissue as in a Kader gastrostomy.

STEP 4.—The muscles are left undisturbed, and the anterior fascia and skin are approximated by interrupted figure-of-eight silkworm-gut sutures. The suture passes through the skin on one side 1 cm. from the edge, and perforates only the skin and superficial fascia. It is then carried over to the opposite fascia and perforates it from above downward and then is made to cross the incision and pass through the opposite fascial sheet from below up and then crosses over the incision to come out through the opposite skin flap 1 cm. from the edge. The drainage tube emerges at the lower angle of the skin incision, and is held in place by a single transfixion suture of silkworm-gut. A small cigarette drain is provided at the lower angle of the wound in order to drain independently the space of Retzius.

Comment.—This type of operation is uniformly successful. There is very little chance of any accident occurring. If the peritoneal cavity is accidentally opened, it can be readily closed; the hemorrhage is very slight, usually so scant as not to re-

quire any ligatures; drainage is efficient and does not offer many difficulties. The exposure is usually ample. The incision in the bladder may be transverse if desired. It is not necessary to apply the sutures with extreme precision; it apparently makes no difference what form the suture takes or whether it accidentally includes mucous membrane, so long as no ligature material is free within the vesical chamber.

TRANSVERSE INCISION

(*Trendelenburg, Kelly, Lower, MacGowan,* 16)

Incision.—With the patient in the Trendelenburg position, a horizontal incision is made about 7 to 10 cm. long in the interspinous fold, slightly curved from internal ring to internal ring with concavity upward, about 6 cm. above the symphysis.

Technic of Operation.—STEP 1.—Divide the skin and superficial and deep fascia down to the sheaths of the recti muscles. Clamp any vessels that bleed. The superficial epigastric and superficial external pudic arteries and veins are usually encountered. Retract the fatty fascial tissue above the line of contemplated incision in the muscle sheaths.

STEP 2.—Incise the anterior sheath of the 2 recti transversely from 1 semilunar line to the other. The intermuscular septum must be divided to allow complete retraction of the anterior fascia and thereby expose the 2 muscles.

In the lower part of the sheath of the rectus will be found the pyramidales muscles, 1 on each side, which take their origin from the pubic bone and symphysis and are inserted into the linea alba about 8 cm. above the symphysis. Separate the pyramidales muscles.

Insert a blunt retractor beneath the body of each rectus muscle and retract gently, taking care not to injure the deep epigastric vessels, which enter the sheath of the rectus by passing over the semilunar fold of Douglas. If the retraction is inadequate, sever the innermost fibers of the rectus from the symphysis.

STEP 3.—By means of gauze dissection, strip off the properitoneal fat and peritoneum until the latter is well off the superior surface of the bladder. The bladder is readily recognized by the attachment of the urachus to the apex, by the blue pink color, by the longitudinal muscle fibers, by its fluctuant quality and by the dichotomous branching of the superficial vesical veins.

STEP 4.—The bladder may be incised longitudinally or transversely. If the former method is used, the technic is as described for vertical cystotomy. If the latter technic is adopted, the bladder may be grasped at its lower angle by a single volsella forceps and 2 linen sutures may be passed through the muscular coat on each side to serve as traction sutures.

STEP 5.—Protect the paravesical tissue by adequate gauze packing, which also prevents the peritoneal reflection from slipping down.

STEP 6.—Incise the bladder transversely between the traction sutures; try to have the incision at the uppermost limit of the elevated bladder.

STEP 7.—In entering the bladder, use a full-bellied knife and give a quick thrust through all the coats. In this way one avoids pushing the mucous membrane before the knife, as may happen if the incision is made too deliberately.

STEP 8.—Swab the bladder dry and carry out whatever surgery may be necessary.

STEP 9.—Remove all gauze packing and close the bladder wound by a Connell suture of No. 2 catgut, plain or iodized, penetrating all the coats of the bladder. Drainage is provided if necessary by any standard drainage tube (Freyer or Marion) at the midpoint of the transverse incision, or the incision is closed in its entirety and drainage provided by a separate stab wound about 2 cm. above or below the line of the bladder incision. Reinforce the closure line by a Cushing stitch of No. 1 chromic gut. Bring the bodies of the 2 recti together by a few interrupted sutures of No. 2 plain catgut. Provide drainage for the prevesical space by means of a small cigarette drain at the lower angle of the wound. Bring the fascial flaps together with continuous suture of No. 2 chromic catgut. Close the skin by interrupted silkworm sutures, the middle stitch transfixing the drainage tube. Transfix cigarette drain with sterile safety pin.

Comment.—The advantage obtained from the transverse incision is the wide exposure of the prevesical space. The disadvantages are that it opens more tissue planes to infection than the vertical; there is an increased liability to hernia, and if infection takes place, it is more difficult to cope adequately with it than when the vertical incision is used.

CYSTOSTOMY OR PERMANENT URINARY FISTULA

Description.—The institution of drainage of the bladder, by means of a permanent fistula.

Indications.—The operation is usually performed as a palliative procedure in advanced malignant disease, tuberculosis or intractable cystitis.

Technic of Operation.—The operation is essentially a cystotomy for permanent drainage and the various steps are as outlined for cystotomy. The special point in the technic is the accurate coaptation of the vesical mucosa to the skin incision. Various mechanical appliances have been devised for maintaining the patency of the stoma. A very efficient one is Stevenson's suprapubic tube.

In obstinate cases of cystitis in women associated with great pain and vesical tenesmus due to cystitis colli or trigonitis, a cystostomy performed through the vesicovaginal septum is a procedure of great value as it gives complete physiological rest to the bladder for 6 to 9 months or until the cystitis is cured. The technic of Kelly (14) is the one usually followed. The patient is put into the knee-chest position. A catheter is introduced into the bladder and the urine withdrawn when the air rushes in and stretches the bladder to maximum. By means of a Sims speculum the posterior vaginal wall is retracted exposing the stretched anterior vaginal wall. A scalpel is plunged through the vesicovaginal septum in the median line and about 2 cm. in front of the cervix. The incision is carried toward the urethra about 1.5 to 2 cm., care being exercised not to injure the sphincter of the internal meatus. The vesical mucosa will usually prolapse into the wound and it is then drawn down over the intervening edge of the septum and accurately sutured to the vaginal mucosa by continuous or interrupted sutures of catgut. The entire operation is readily carried out by infiltrating the vaginal mucous membrane and septum with 3 per cent. novocain solution.

OPERATION FOR CONTRACTURE OF THE VESICAL NECK

(*Mercier, Fuller, Keyes, Chetwood*)

Description.—The division or excision of an organized fibroid ring surrounding the internal urinary meatus of the bladder.

Operative Procedures.—Incision of fibroid ring by:

I. Suprapubic cystotomy.
II. Perineal section,
    a. Median prostatotomy.
    b. Bottini galvanocautery.

Excision of fibroid ring by:

I. Suprapubic cystotomy
II. Perineal cystotomy
III. Urethral cystotomy (Punch operation of Young).

The operation when performed through a suprapubic wound is essentially a cystotomy with either division of the occlusive ring or its excision. If incision is carried out, the "bar" is divided from above downward and before backward, well into the basal prostatic tissue. If excision is decided upon and it seems the better procedure, the occlusive tissue is removed en masse. Since the tissue is usually of a fibroid nature, it does not lend itself to any enucleative maneuver, but has to be excised by sharp dissection. On the whole, this condition is best treated by perineal measures. (See Surgery of the Prostate, page 700.)

LITHOLAPAXY

Instruments.

Lithotrite—usually 3 sizes—fenestrated.
Aspirators and washing bottles—usually 3.
Washing tubes.
Catheter.
Piston syringe.

Description.—The introduction into the bladder of a special instrument known as a lithotrite for the purpose of grasping and crushing vesical calculi, with the subsequent aspiration of the mineral detritus through a washing tube by means of an aspirator.

Indications.—The success of litholapaxy depends essentially upon the skill and technic of the operator and the methodical way in which the operation is conducted. The operation has its best indication in those cases showing vesical calculi within a relatively clean, non-infected bladder. For numerous small calculi or for encysted calculi or calculi within diverticula, it is not applicable.

Preparation.—General anesthesia. Penis and meatus rendered as aseptic as possible.

Position.—The patient is placed in a typical male-cystoscopy position, with the pelvis well elevated.

Technic of Operation.—STEP 1.—A soft rubber catheter, about 26 French, is well lubricated and introduced into the bladder. After the urine is withdrawn, about 200 to 300 c. c. of sterile saturated boric acid solution is introduced into the bladder and the catheter is withdrawn.

STEP 2.—The large size lithotrite is passed closed into the bladder, much after the fashion of introducing a sound. Considerable care is required in passing the abrupt curve of the instrument up through the prostatic urethra. By maintaining the shank of the instrument in a more vertical position, until the tip passes under the triangular ligament, little difficulty is experienced. After the bladder has been entered, the lithotrite is gently passed backward until the closed jaws rest on the posterior bladder wall.

STEP 3.—The location of the stone is determined by gently tapping the bladder, using the lithotrite as a stone searcher. By keeping absolutely in the midline, and pressing the angle of the jaws well into the base of the bladder, the calculus will usually gravitate to the instrument. If not, by slight lateral rotations through 35° to 45°, a "click" is usually obtained. Having located the stone, return to midline position. Keep the jaws well on the base of the bladder.

STEP 4.—Open the jaws by pulling the male segment up and rotate the open jaws to the previously determined position of the stone. Grasp the stone and give the knob a half turn to fix the stone within the grasp of the instrument. Here certain precautions are necessary to see that the mucous membrane is not included within the grasp of the instrument. In order to determine this point, withdraw the instrument about 2 cm. and see if it rotates freely. If the mucous membrane is entrapped, there will be a distinct "pull" and lack of free rotation. If this occurs, unlock and repeat procedure. The instrument is so constructed as almost to preclude the possibility of any tissue getting within the jaws except with a very careless technic. With the calculus firmly grasped, crush the stone by turning the handle.

STEP 5.—Repeat the procedure a number of times until satisfied that the stone has been amply fragmentized.

STEP 6.—Withdraw the lithotrite.

STEP 7.—Introduce as large a washing tube as will pass through the urethra, and couple this with an aspirator after being satisfied that no air is introduced into the bladder, which would impair the efficiency of the aspirator. The entrance of air into the bladder can be entirely avoided by filling the washing tube with the solution from a piston syringe, while the washing tube is still within the prostatic urethra.

STEP 8.—Alternate compression and relaxation of the bulb of the aspirator cause an influx and reflux of fluid into the bladder, and the mineral detritus is aspirated into the bottle of the aspirator. Repeat this process until the reflux is clear. Withdraw the washing tube and repeat the maneuvers with the lithotrite, using a smaller instrument. When satisfied by absence of "clicks" that the fragments have been adequately crushed, remove the lithotrite and repeat the procedure with the washing tube.

STEP 9.—Wash the bladder by means of a catheter and saturated solution of boric acid, and finally distend the bladder with 1:5,000 silver nitrate solution, and withdraw the fluid.

Dangers.—With strict asepsis and careful attention to detail, the dangers are extremely slight. There is a possible danger from hemorrhage either from grasping the bladder wall or from actual trauma to the mucosa during the crushing of the fragments. With the fenestrated instrument there is no possibility of plugging the female blade. There is, however, the chance of plugging the washing tube. This accident will be detected by the change in the suction pressure as detected in the bulb. If difficulties are experienced in introducing the lithotrite through the external urinary meatus, a preliminary meatotomy is indicated. Occasionally considerable trouble may be met in passing the long straight shank with abrupt curve through the prostatic urethra. With patience, however, and maintaining the shank vertical until the beak engages under the triangular ligament with counterpressure on the perineum, little difficulty will be experienced. A stone in a pocket or an encysted stone cannot, as a rule, be grasped. The same objection applies to calculi within diverticula. Rarely a calculus is too hard to be crushed. If this occurs, suprapubic cystotomy is clearly indicated. **A common difficulty is inability to crush the last fragment or to remove it with the washing tube. This vitiates the one important advantage of the operation, namely, complete removal at one sitting.**

Complications.—The complications are those germane to any extensive instrumentation of the bladder: retention, hemorrhage, sepsis, prostatic infection, orchitis, epididymitis, phlebitis, surgical kidney, catarrhal desquamation, and phosphatic "bladder."

Results.—The results obtained from a complete and carefully executed litholapaxy are excellent. If no stone has been left behind, no new stone passed from the kidney, and the bladder upon re-examination a month after operation is found to be free of stone, the result may be said to be ideal. It is a good operation, with well-defined limitations even when carried out by an experienced and adept operator.

(I have had a large experience in this operation and think highly of it in selected cases.—EDITOR.)

SUBTOTAL CYSTECTOMY

(*Squier and Heyd,* 28)

Description.—An operation for removal of a part or all of the bladder. Generally speaking, most operations involving the removal of a portion of the bladder are considered under the head of cystectomy, complete removal of the bladder being more in the nature of an operative curiosity than a feasible surgical procedure. Subtotal cystectomy may be carried out intra- or transperitoneally or as a straight extraperitoneal operation. It has been repeatedly observed that the bladder possesses wonderful reparative powers, and it has been demonstrated that from ⅔ to ⅘ of the bladder may be removed with subsequent adaptation to form an efficient urinary receptacle. (Harris 9, Rövsing 22.)

Incision.—The incision may be a transverse or a median longitudinal incision (see Cystotomy). The longitudinal incision begins 1 in. above the navel on the left side and extends downward to the symphysis.

Technic of Operation.—STEP 1.—The anterior sheath of the rectus muscle is divided about 1 cm. to the left of the midline and the left rectus displaced outward. The posterior sheath, above the semilunar fold of Douglas, is incised, and the properitoneal fat exposed from the navel to the symphysis. By gently swabbing the fat and loose connective tissue up toward the navel, 3 important structures or surgical landmarks are brought into view. In the median line is found the urachus extending from the navel to the vesical apex. From the navel, on each side of the urachus, are found the obliterated hypogastric arteries, represented as divergent fibrous cords (Fig. 2). Having located these structures, 2 procedures are in order, either to open the peritoneal cavity and continue the operation as a transperitoneal procedure or to carry out the technic entirely as an extraperitoneal operation.

STEP 2.—The peritoneum is incised from the navel down to a point corresponding to the semilunar fold of Douglas. The patient is placed in an extreme Trendelenburg position, and the intestines gently deposited in the upper portion of the abdominal cavity. The pelvis is thoroughly walled off by 1 or 2 long continuous rolls of sterile gauze. Two laparotomy pads are attached at each end of the wound in order to protect the incision from implantation of tumor cells.

STEP 3.—The urachus is grasped at the lower angle of the peritoneal incision by a Barrett's intestinal forceps. Traction is made upward, throwing into relief the obliterated hypogastric arteries as they divaricate to enter the true pelvis. The left obliterated hypogastric artery is grasped with forceps and traction made upward and to the right (Fig. 3). By blunt dissection between the obliterated hypogastric artery and the lateral wall of the pelvis, the left vas deferens is brought into view as it courses along the pelvic wall to the inner side of the obliterated hypogastric artery.

STEP 4.—A blunt, single-hook retractor is passed under the left vas deferens and gentle traction exerted (Fig. 4). Blunt dissection is continued downward along the course of the vas deferens and the pelvic ureter is uncovered as it bends inward above the fascia of the pelvic floor to enter the bladder, the ureter at this point being crossed on its inner side by the vas deferens. A similar exposure is made on the opposite side and the right ureter exposed. Any radical procedure directed to the extirpation of neoplasms of the bladder must have the 2 ureters exposed and constantly in view. This is the essential point in any radical technic.

STEP 5.—The urachus is divided close to the summit of the bladder, and traction is made upon the bladder downward toward the symphysis (Fig. 5). From the 2 points of lateral dissection previously made the peritoneum is stripped off the fundal surface of the bladder. The denudation extends deep into the rectovesical space and the peritoneal culdesac of Douglas is pushed upward and backward. If the peritoneum is found firmly attached to the bladder and already the seat of malignant infiltration, this area is left undisturbed and a wide encircling incision made about the infiltrated peritoneum. If the peritoneum is not infiltrated, the entire bladder, except the anterior or pubovesical attachment, should be freely mobilized, both ureters free, and the superior poles of the vesical and the upper portion of the posterior surface of the trigone in sight (Fig. 6). This entire procedure can be carried out without entering the peritoneal cavity. Occasionally, the peritoneum is torn and should be brought together with No. 1 plain catgut. No hemorrhage of any moment is encountered and the venous oozing is readily controlled by hot wet pads.

STEP 6.—The denuded lamella of peritoneum is carefully attached to the upper end of the abdominal incision, so that, for all further operative procedures, the peritoneal cavity is practically closed.

STEP 7.—The bladder is grasped high up on the posterior surface, and an incision is made in a longitudinal direction (Fig. 6) about 3 cm. in length. Through this opening an inspection of the bladder is made and the topography of the tumor determined (Fig. 7). The incision is extended in any direction that may be necessary for proper operative exposure. Since, in the majority of instances, the tumor will be found to occupy the summit, side, or trigone of the bladder, an incision downward in the posterior median line, which divides the organ in half, will be the usual incision of election (Fig. 8).

STEP 8.—The neoplasm is excised en masse, together with a wide margin

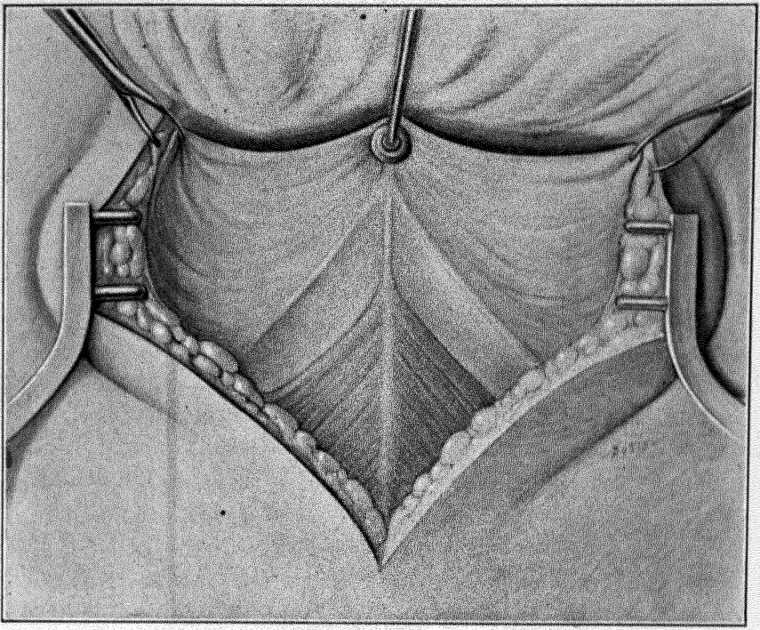

FIG. 2.—EXPOSURE OF PREVESICAL SPACE. Urachus and diverging obliterated hypogastric arteries held taut by intestinal forceps.

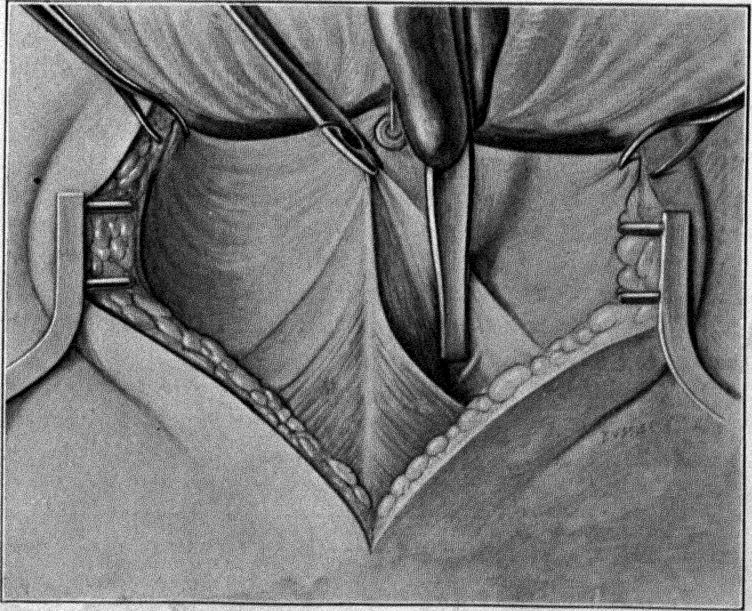

FIG. 3.—EXPOSURE OF THE LEFT VAS DEFERENS BY BLUNT DISSECTION ALONG THE COURSE OF LEFT OBLITERATED HYPOGASTRIC ARTERY.

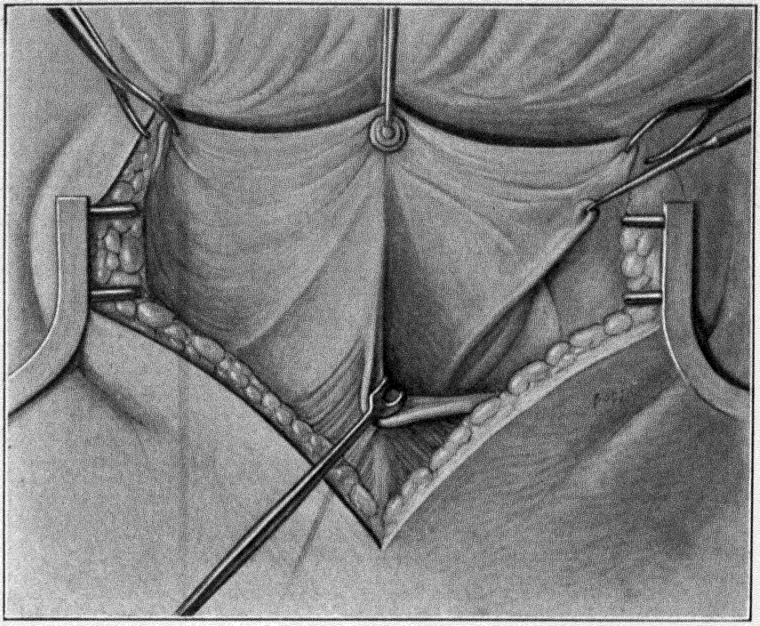

Fig. 4.—Exposure of Left Ureter by Blunt Dissection Along the Course of Left Vas Deferens.

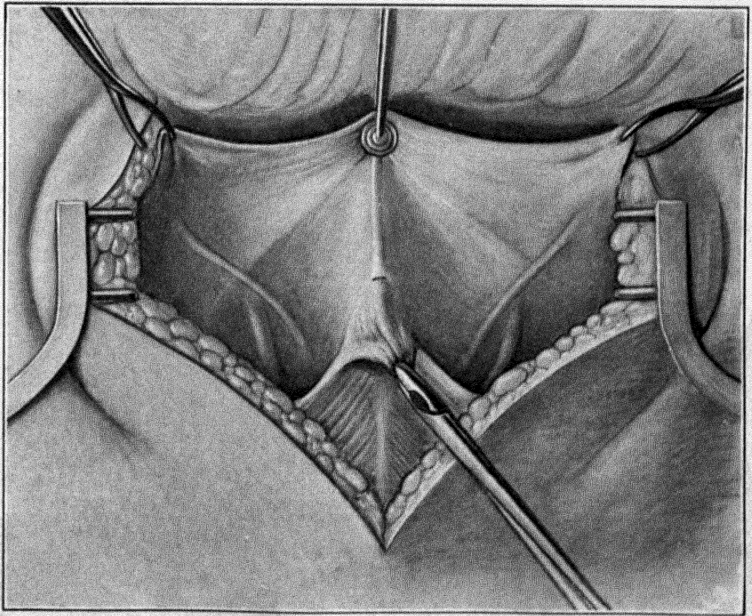

Fig. 5.—The Final Separation of Peritoneum from the Bladder Exposing Both Ureters, Vasa Deferentia, and Upper Pole of Trigone. The urachus is divided close to the summit of the bladder.

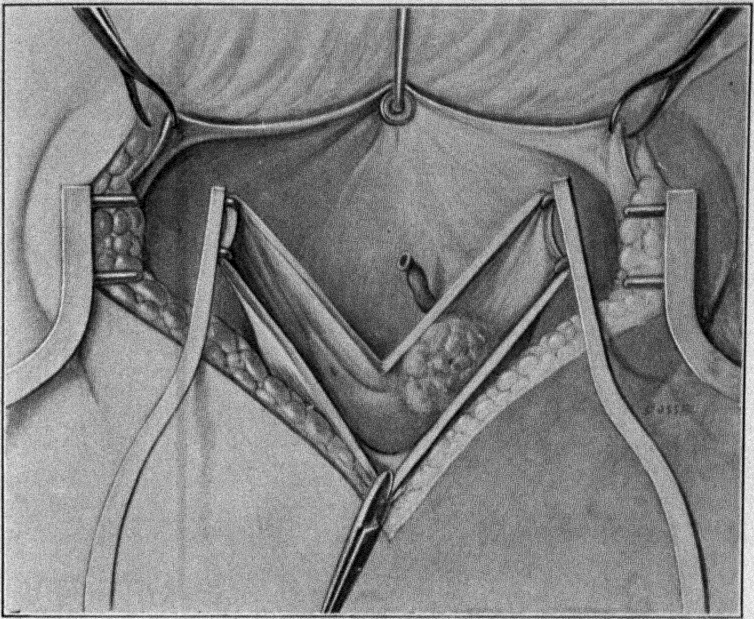

Fig. 8.—Bisection of Posterior Bladder Wall Previous to Extirpation of Neoplasm.

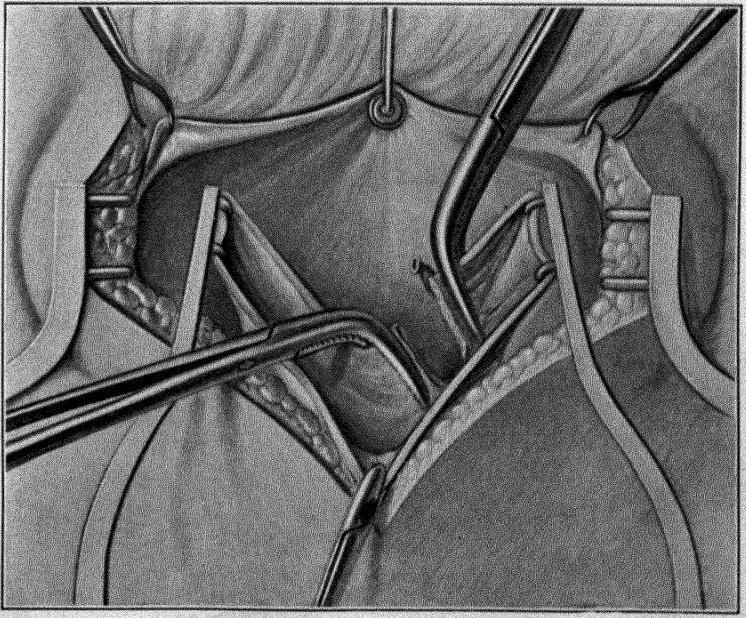

Fig. 9.—The Neoplasm and Affected Ureter Excised en Masse with Wide Encircling Margin of Healthy Tissue. Hemostasis assured by right angle tissue forceps; temporary ligature around proximal ureter.

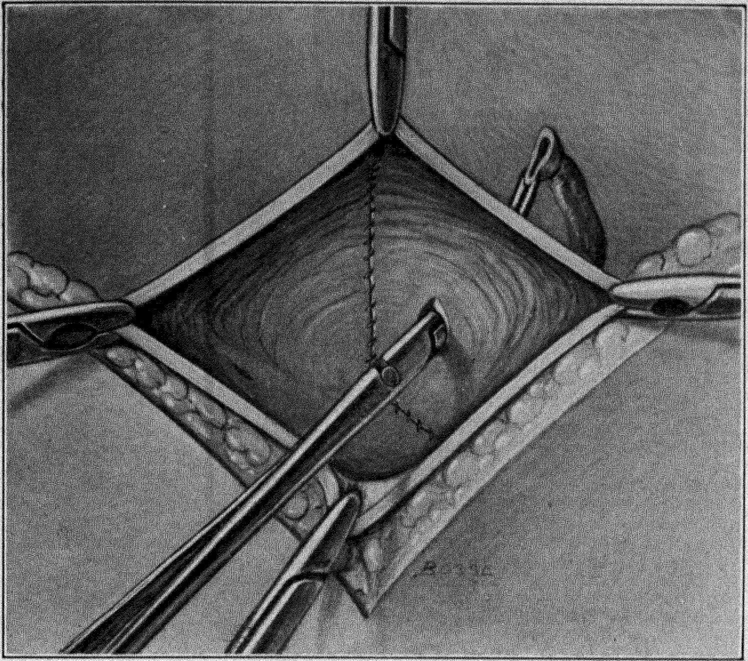

FIG. 10.—PARTIAL CLOSURE OF DEFECT IN BLADDER WALL AND STAB WOUND FOR IMPLANTATION OF URETER. Dressing forceps grasping ureter.

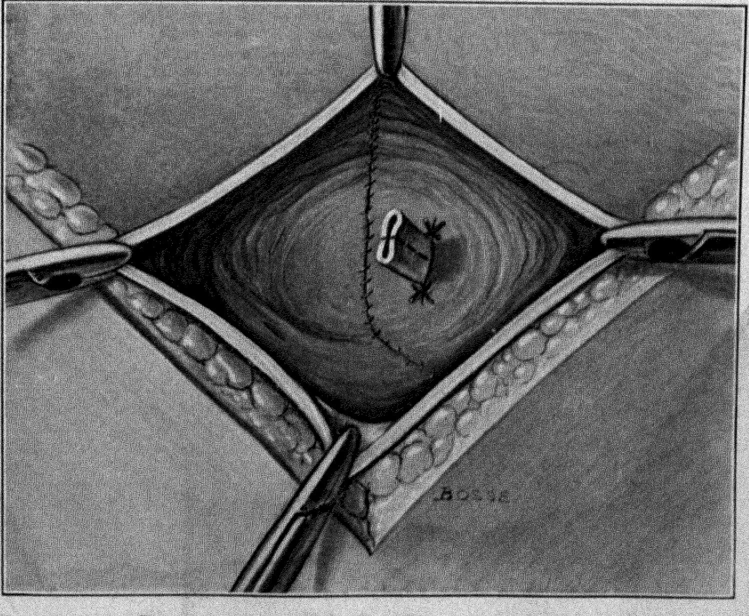

FIG. 11.—THE URETER IS BROUGHT THROUGH THE STAB WOUND AND ANCHORED TO THE BLADDER WALL.

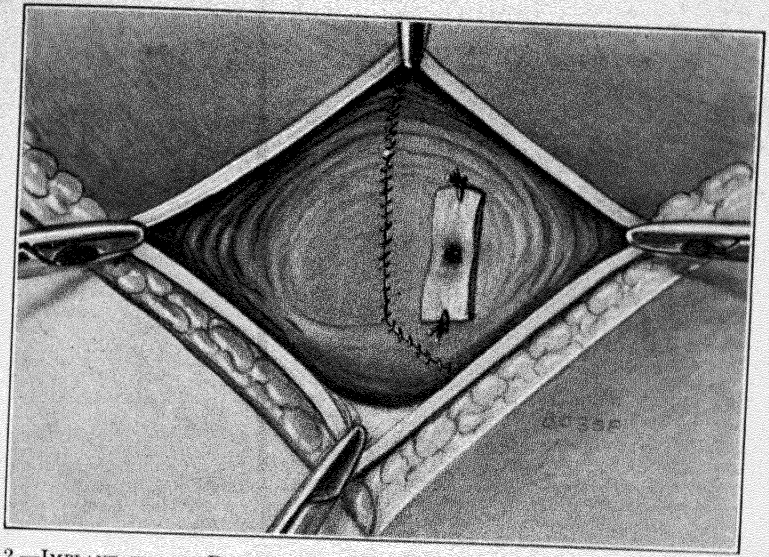

FIG. 12.—IMPLANTATION OF DIVIDED URETER AFTER PARTIAL CLOSURE OF BLADDER DEFECT.

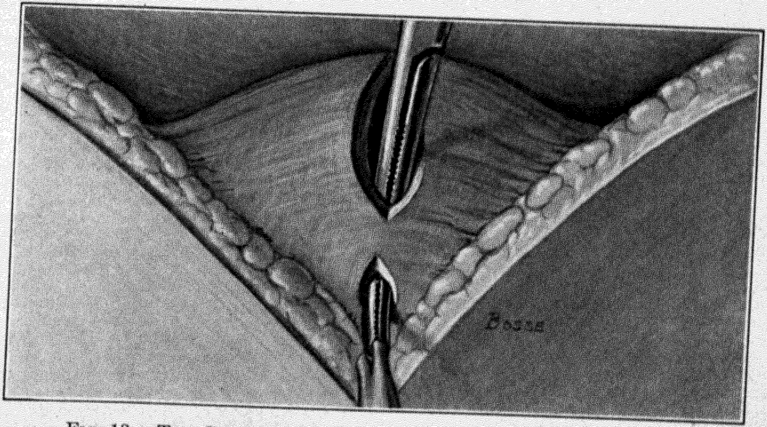

FIG. 13.—THE COUNTER OPENING FOR DRAINAGE OF THE BLADDER.

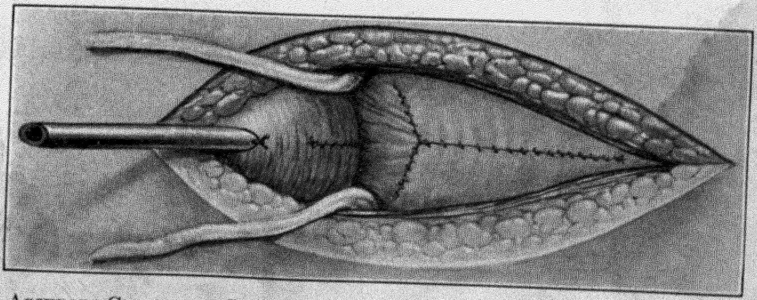

FIG. 14.—ACCURATE CLOSURE OF PERITONEAL CAVITY SHOWING THE TWO CIGARETTE DRAINS AND THE SEPARATE STAB WOUND FOR DRAINAGE OF THE BLADDER.

of healthy, uninvaded tissue comprising the entire thickness of the bladder wall (Fig. 9). The exposure of the ureter, which has already been made, now becomes of prime importance. If the ureter is affected, it is divided between ligatures above the growth, and the distal portion is removed with the tumor. The proximal portion is allowed to remain undisturbed until partial closure of the bladder defect is accomplished.

STEP 9.—The hiatus of the bladder wall after excision of the tumor is partially repaired as illustrated in Figure 10, the method of closure being similar to the Connell intestinal suture with No. 2 chromic catgut. A stab-wound is made through the bladder wall at a point approximating the normal ureteral opening and the proximal portion of the divided ureter is drawn through this opening with a thin dressing forceps (Fig. 10).

STEP 10.—The ureter is brought through the stab wound and anchored to the bladder wall (Fig. 11). About 1 to 2 cm. of the ureter is allowed to protrude into the bladder. Two flaps are made by bisection of the ureteral stump and the flaps turned back an anchored in situ (Fig. 12). The remaining defect in the bladder is closed with a Connell suture, as above, and drainage of the bladder instituted by means of a stab, buttonhole incision, anterior to the line of closure and at a point which will correspond to the apex or summit of the bladder when the operation is completed (Fig. 13). Through this aperture a No. 26 F. soft rubber catheter is drawn and sutured in situ. A drainage tube inserted in this manner insures against leakage along the tube into the prevesical space.

STEP 11.—The final step is the reposition of the peritoneum over the vesical suture line and an accurate closure of the peritoneum. If the peritoneum is invaded by the growth, the involved portion is resected with the growth and the peritoneal hiatus closed after the usual fashion, particular care being taken to prevent a peritoneal suture line being superimposed upon a bladder suture line. A cigarette drain is inserted into each lateral space, leading down to the ureter, and the abdomen is closed with figure-of-eight silkworm sutures. In addition, a self-retaining catheter is inserted (Fig. 14).

Comments.—The operative treatment of tumors of the bladder has been inadequate in preventing local recurrence and implantation metastases. In a case of malignant tumor, the tumor per se should not be handled, and the excision must be through all the coats of the bladder and the peritoneum adjacent to the bladder wall if found to be infiltrated. The wide denudation in the above technic can be made with the patient in a high Trendelenburg position, either intra- or extraperitoneally. The vas deferens in the male offers the most reliable and quickest way of reaching the terminal ureter. The blunt dissection along the lateral walls of the pelvis allows for exploration about the iliac vessels for metastatic glands. In the female, the relation of the uterine artery allows for an accurate localization of the terminal ureter. Any cystectomy for vesical tumor should be radical along the lines indicated above. In substance there is no difference between intra- and extraperitoneal surgery for this class of work. Leakage, if it does occur, does not take place into the peritoneal cavity when the peritoneum

has been sutured carefully with a serous approximation of surfaces. If, after opening the bladder, a malignant neoplasm is found to be excavated or sessile, cauterization of the base or surface of the tumor is a procedure of undoubted value. After excision searing the cut edges with the Paquelin cautery before suturing is a very wise precaution. The use of 50 per cent. resorcin or 1:500 bichlorid of mercury, swabbed about the bladder, is useful in destroying any detached tumor particles.

TRANSPERITONEAL OPERATION FOR VESICAL NEOPLASMS

(*Harrington, C. H. Mayo, Judd,* 11, 12, 13)

Incision.—An inferior median laparotomy incision is made from the symphysis to the navel. The patient is placed in a high Trendelenburg position. The liver and pelvic cavity are explored with the hand for metastases.

The intestines and omentum are gently placed in the upper abdomen and protected by continuous rolls of sterile gauze. The abdominal incision is also protected from contamination by two laparotomy pads clamped at each end by Backhaus towel clamps.

STEP 2.—The posterior bladder surface is grasped with tenacula forceps, one on either side of the median line, and a longitudinal incision is made, beginning on the peritoneal surface and extending well back of the base of the bladder.

STEP 3.—Gently swab the bladder dry and accurately determine the topography of the tumor. If pedunculated, grasp by pair of curved hemostats and excise with cautery including a portion of the healthy mucosa and submucosa. Thoroughly cauterize the base and leave the cauterized surface to granulate. If the tumor is malignant and has an indurated base, excise the entire thickness of the bladder wall, taking care to have a wide encircling border of healthy non-invaded tissue.

STEP 4.—If the bladder is involved at the ureteral meatus, the ureter must be resected and gently placed out of the field of operation. Complete the excision of the tumor and transplant the ureter. (See Subtotal Cystectomy, page 723.)

STEP 5.—Vesical closure. Close the wound in the bladder as in an enterorrhaphy. The first row of sutures is of No. 2 chromic catgut, transfixing all the coats in the form of a running Connell suture. This suture line is reinforced by a linen stitch including the peritoneum and parallel with the previous suture line.

STEP 6.—Establish drainage as indicated. As a rule, it is not necessary to drain the peritoneum. Drain the bladder through a separate stab wound 2 cm. away from the top of the vesical incision, and place a cigarette drain in the space of Retzius and to the ureteric angle if the ureter has been resected.

STEP 7.—Abdominal closure in layers as in an ordinary laparotomy is the last step. A self-retaining catheter may be used if desired.

PARTIAL CYSTECTOMY FOR NEOPLASMS OF THE FUNDUS OF THE URINARY BLADDER

(*Hagner,* 10)

Description.—A special operative technic for the extirpation of small, definitely localized neoplasms of the fundus and superior lateral walls of the urinary bladder. The essential feature of the operation is the accurate localization of the tumor by means of "guide" sutures, passed through the bladder wall after a suprapubic exposure of the fundus. These guide sutures are passed under the guidance of a cystoscope in the bladder and penetrate only healthy, non-invaded bladder tissue; they act as guides and tractors and obviate any handling of the tumor or surrounding bladder wall.

Indications.—This operation is best indicated in small, definitely circumscribed tumors of the fundus of the bladder whether they are benign or malignant. The operation is impracticable for tumors of the bladder base, which, unfortunately, is the most common situation for vesical neoplasms.

Technic of Operation.—STEP 1.—The patient is placed in the male-cystoscopy position and the bladder is irrigated with saturated boric acid solution. If bleeding is troublesome adrenalin solution 1 : 10,000 is instilled and allowed to remain for 5 minutes. Then, the bladder is distended with 400 c. c. of normal saline solution and a cystoscope introduced and held in situ by an assistant.

STEP 2.—After preliminary surgical preparation of the lower abdomen steps 1 and 2 of a longitudinal or step 1, 2 or 3 of a transverse suprapubic cystotomy are performed.

STEP 3. The growth is then inspected through the cystoscope. While the right hand holds the cystoscope a round pointed needle carrying No. 2 plain catgut is indented on the fundus of the bladder by the left hand and produces a "dimpling" on the interior of the bladder which is readily seen through the cystoscope. By observation a point is selected 1 to 2 cm. to the left of the tumor and the needle is passed down, in and out, penetrating the entire thickness of the bladder wall. The same maneuver is carried out to the right, and above and below the neoplasm. By traction upon the four guide sutures the fundus is held taut and the tumor, with a surrounding margin of healthy tissue, is enclosed in a rough quadrilateral, bounded by the four guide sutures. The cystoscope is now withdrawn (Fig. 15).

STEP 4.—With a sharp scalpel incise the bladder to the outer side of the four sutures, and remove the tumor en masse. Grasp the cut edge of the bladder wall with two or three Allis clamps and close wound after the manner of a suprapubic cystotomy.

COMMENT.—If the growth is subjacent to the peritoneum it will not be possible to place the superior suture. In such an event, the technic is carried out with three sutures and the incision in the bladder wall carried upward into the peritoneal cavity and the portion of parietal peritoneum covering the growth is removed. This techni will be applicable to relatively few cases. In the hands of an expert operator it is an operation of promise. It has inherently two disadvantages: (1) No cystoscopis (Squier) can tell by means of a cystoscope the exact limits of malignant infiltration or whether a tumor is benign or malignant. (2) A tendency to excise too little tissue rather than too much. It has the great merit of absolutely avoiding all manipulation of the tumor itself and its removal en masse.

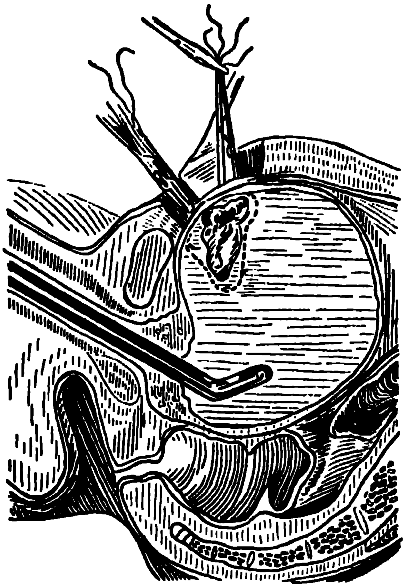

Fig. 15.—The Guide Sutures Passed to Outline Tumor at the Fundus of Bladder. (Hagner.)

DIVERTICULA OF THE BLADDER

The surgical treatment of diverticula of the bladder is dependent upon their location, peritoneal attachments, and their relation to the ureters and trigone. There are 2 surgical procedures.

1. Excision in toto, either extraperitoneally (Cabot; Young, 31; Chute, 7, Lower, 15), transperitoneally (Beers, 5), or intravesically (Young, 31).
2. Plastic resection with suture of the cut edges separately so as to transform the diverticula and bladder into a common cavity (Squier, 27; Young, 31).

Depending upon the operative findings, certain variations in technic will have to be adopted. As a preliminary measure, the diverticulum should be accurately outlined by collargol X-ray pictures. A stereoscopic picture will be a material aid in bringing out the space relationship of the diverticulum. Catheters should be placed in the ureters immediately preceding operation. If distention of the bladder is deemed necessary, a soft rubber catheter should be left in the urethra previous to operation.

EXCISION OPERATION FOR REMOVING DIVERTICULA OF THE URINARY BLADDER

(*Cabot, Lower,* 15)

Incision.—The exposure of the bladder may be accomplished by the longitudinal or transverse cystotomy (see page 723).

Technic of Operation. STEP 1.—The interior of the bladder is exposed with flexible retractors and swabbed dry. The orifice of the diverticulum and its relation to the ureters and trigone are clearly determined. The diverticulum is then packed with a strip of sterile gauze until it is converted into a semisolid tumor (Fig. 16).

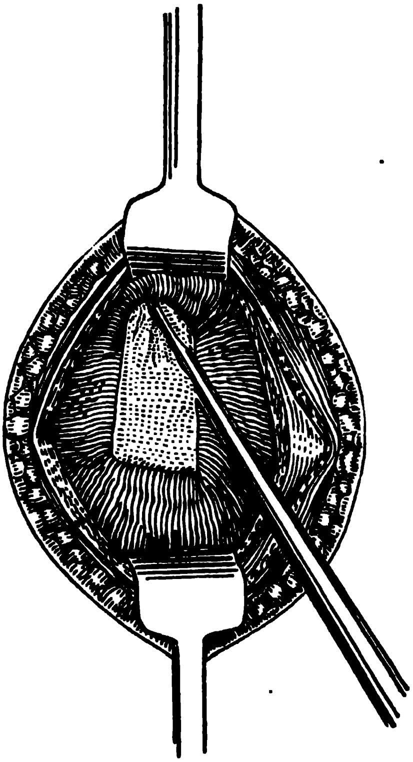

FIG. 16.—STRIP OF STERILE GAUZE PROTRUDING THROUGH ORIFICE OF DIVERTICULUM. (Lower.)

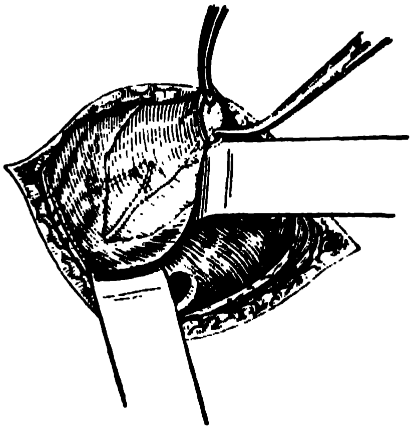

FIG. 17.—DIVISION OF THE NECK OF THE DIVERTICULUM. (Lower.)

STEP 2.—The bladder and the attached diverticulum are carefully separated from the peritoneum. Usually little difficulty is experienced until the region of the trigone and rectum is reached, when careful dissection may be necessary.

STEP 3.—The index finger of the left hand is inserted into the bladder and through the orifice of the diverticulum. Traction is made upon the bladder upward and forward and to the right or to the left, as may be indicated. By this maneuver the neck of the diverticulum is brought into view.

STEP 4.—Divide the neck of the diverticulum (Fig. 17) in order to entirely separate the diverticulum from the bladder. This may call for considerable operative work upon one or other of the ureters or upon the trigone, for with the gradual enlargement of a diverticulum the adjacent bladder wall is drawn up into and forms part of the wall of the diverticulum. This must carry with it the ureter and the ureteric meatus.

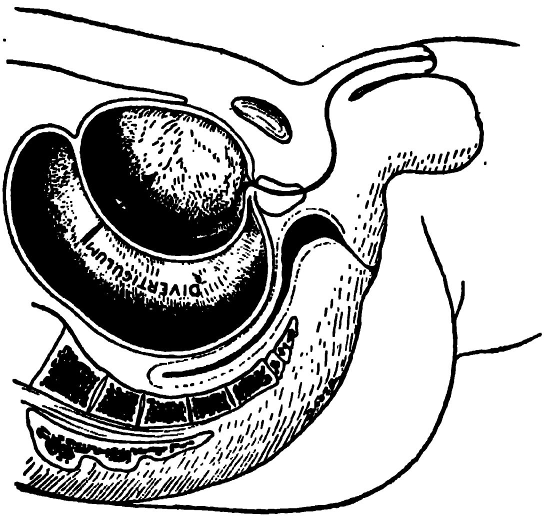

FIG. 18.—THE RELATION OF DIVERTICULUM WITH ITS ORIFICE TO THE BLADDER.

STEP 5.—If the ureter is situated within or at the orifice of the diverticulum, divide the ureter by a circular incision and place a temporary ligature around the proximal end of the divided ureter to prevent the escape of urine during the remainder of the operation. Remove the diverticulum en masse.

STEP 6.—Transplant the proximal ureter into the bladder (page 733) and complete all vesical surgery.

STEP 7.—Close the vesical and abdominal wound with drainage, as indicated under Cystotomy (page 723).

PLASTIC RESECTION WITH SUTURE OF THE CUT EDGES SEPARATELY SO AS TO TRANSFORM DIVERTICULA INTO ONE COMMON CAVITY

(*Squier*, 27; *Young*, 31)

Incision.—With the patient in the high Trendelenburg position, make an incision as for suprapubic cystotomy. The operation may be conducted as an extraperitoneal or as a transperitoneal operation.

Operative Technic.—STEP 1.—Strip back the peritoneal reflection by means of gauze dissection. Divide the urachus about 3 cm. above the apex of the bladder. With an Allis clamp, make traction upon the bladder upward and forward and to the right or to the left as indicated. Strip the peritoneum well back from the lateral walls of the bladder.

STEP 2.—Incise the bladder in a longitudinal direction. Accurately determine the location of the ureters and their relation to the diverticulum.

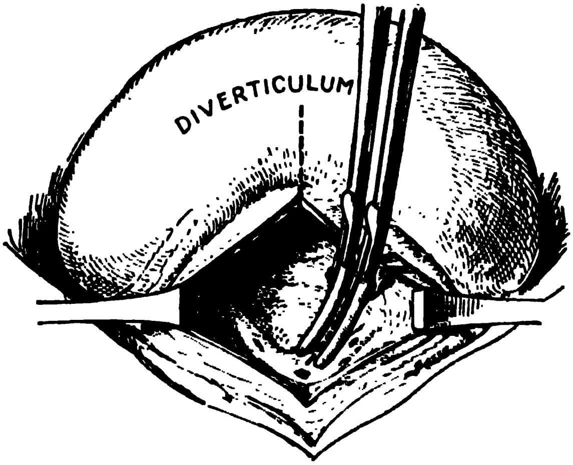

FIG. 19.—DIVISION, BETWEEN CLAMPS, OF WALLS OF BLADDER AND DIVERTICULUM.

STEP 3.—Place 2 intestinal clamps with 1 blade of each in the diverticulum and 1 blade of each in the bladder (Figs. 18 and 19). This brings the posterior bladder wall and the anterior wall of the diverticulum in contact, the direction of the clamps being downward and inward from the diverticular orifice toward the internal vesical meatus

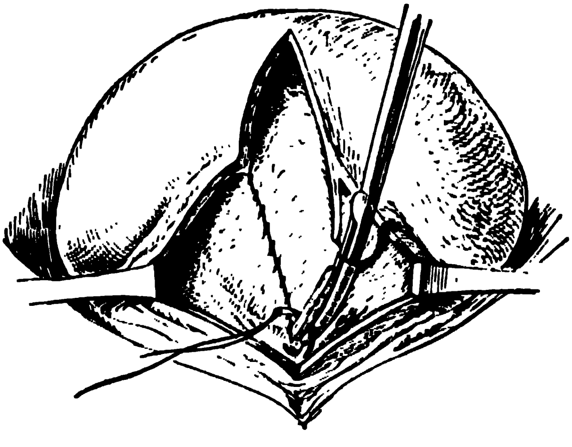

FIG. 20.—APPROXIMATION OF CUT EDGES WITH RUNNING STITCH, CONVERTING INTO ONE THE CAVITIES OF BOTH BLADDER AND DIVERTICULUM.

STEP 4.—Divide the wall of the diverticulum and the bladder between these clamps well down into the trigone (Fig. 19). Particular care must be taken to avoid injury to the ureter or ureteric meatus.

STEP 5.—The cut edges are carefully approximated with a No. 2, plain or iodized continuous catgut suture, thereby uniting the mucous membrane of the diverticulum and bladder on each side of the incision and converting the 2 cavities into 1 chamber (Figs. 20 and 21).

STEP 6.—Remove the upper portion of the diverticulum and what excess diverticular tissue may be necessary to diminish the size of the newly constructed vesical chamber and close the vesical defect by plastic approximation.

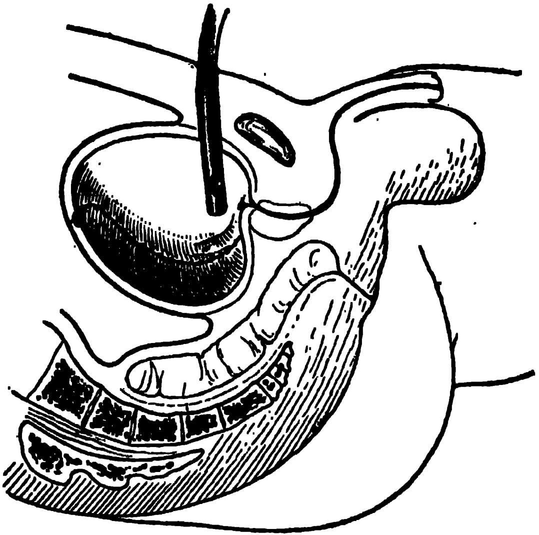

FIG. 21.—DRAINAGE AFTER OPERATION BY MEANS OF SUPRAPUBIC TUBE. SUPERIOR PORTION OF DIVERTICULUM REMOVED.

STEP 7.—Close the vesical and abdominal wound with drainage as indicated under Cystotomy (page 723).

Comment.—Simple catheterization or vesical drainage to withdraw foul urine from the diverticulum and treating the cystitis might be of temporary value, but would be wholly inefficient for permanent results. Linear enlargement of the orifice, as practiced by Chute, is of equivocal value and not without danger, as Young points out, for in most instances the diverticulum is firmly attached to the bladder only by its neck around the orifice, and the adjacent external surfaces of bladder and diverticulum are merely coaptated and loosely bound by fibrous tissue, and do not form a solid septum, so that extensive incision without suture would probably be very dangerous, owing to the possibility of prevesical extravasation of urine. An anastomosis between diverticulum and bladder would be a rare possibility on account of the necessarily peculiar anatomical conformation of bladder and diverticulum. In short, cases may arise necessitating a varying application of some or all of the technical points elaborated above.

CYSTS OF THE BLADDER

With the exception of diverticular and atonic dilatations, cysts of the bladder are rare. However, an echinococcus cyst will occasionally be found, either as an implantation or gravitation cyst from a lesion in the upper abdomen or as a secondary growth in the bladder from a primary focus in the kidney. The operative treatment of this condition will demand the application of general surgical technic to the special location of the cyst or cysts. The difficulties to be met and the operative procedure to deal with them will be apparent by reference to figures.

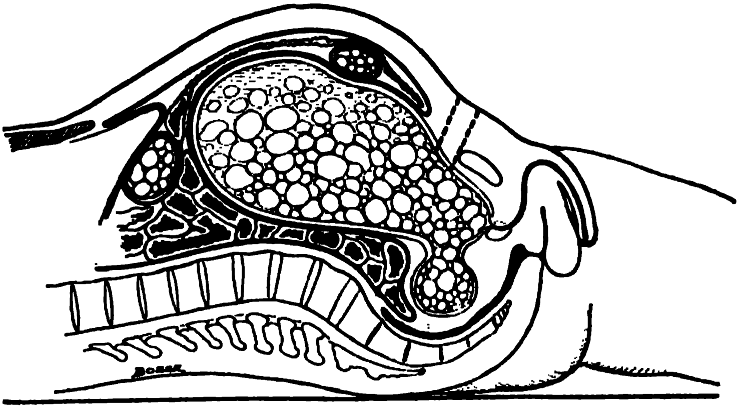

FIG. 22.—RECTOVESICAL CYST, CYST DISTENDED BLADDER, CYST ON LIVER SURFACE AND CYST OF OMENTUM.

RECTOVESICAL ECHINOCOCCUS CYST

Pathology (Figs. 22, 23, 24, and 25).—Original focus in liver. Secondary foci in omentum and rectovesical space. The last has free communication with the bladder, which is filled with daughter cysts (Squier, 26).

Technic of Operation.—STEP 1.—Primary cystostomy is done for temporary drainage (Fig. 23). (For technic, see page 727.)

After two or three weeks of complete physiological rest to the bladder the second stage of the operation is performed.

STEP 2.—With the patient in the Trendelenburg position, the bladder is thoroughly packed with iodoform gauze; the peritoneal cavity is opened, the intestines deposited in the upper abdomen with the viscera, wound surfaces and peritoneal cavity thoroughly protected by sterile gauze pads or continuous rolls. The cyst of omentum is excised.[1]

STEP 3.—The bladder incision is lengthened in order to freely expose the base of the bladder. The communication between mother cyst and bladder

[1] The primary focus in the liver was also excised by resection of right lobe of liver.

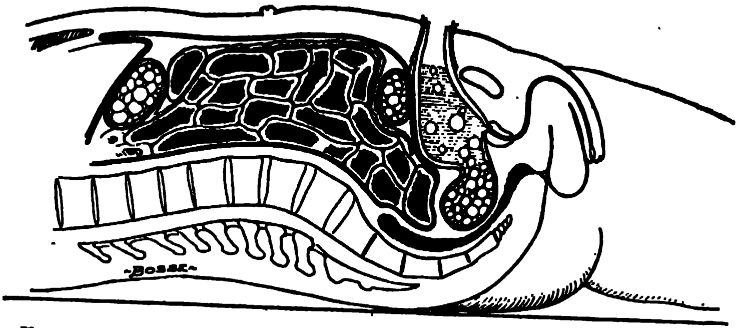

FIG. 23.—THE BLADDER SUTURED TO SKIN FOR DRAINAGE—CYSTOSTOMY.

lying below the peritoneal reflection between bladder and rectum is accurately determined.

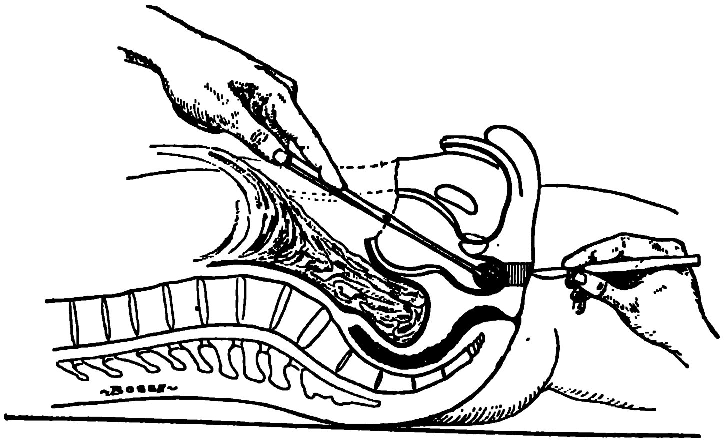

FIG. 24.—THE MOTHER CYST INCISED THROUGH THE PERINEUM.

A sponge holder, carrying a small gauze sponge, is introduced into the mother cyst through the opening in the floor of the bladder and then pushed

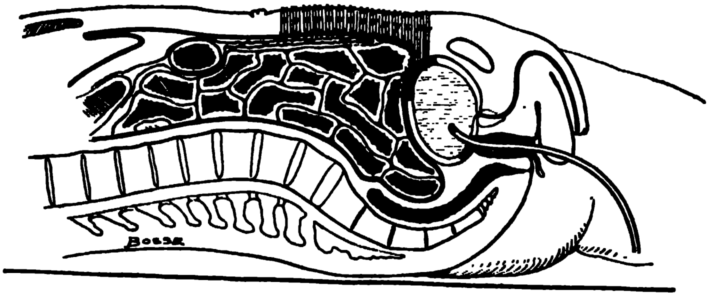

FIG. 25.—THE CYST WALL SUTURED TO SKIN OF PERINEUM. Opening between bladder and cyst closed up to catheter inserted for drainage. Wound in fundus of bladder closed without drainage. Peritoneum and abdominal wound closed.

down toward the perineum. A perineal dissection is then made between rectum and prostate and the cyst capsule pulled down, incised, and sutured to the skin of the perineum, thus marsupializing the cyst to the integument of the perineum (Fig. 24).

STEP 4.—Through the perineal opening the mother cyst is curetted and pure carbolic acid applied to its wall.

STEP 5.—The communication between cyst and trigone is closed, after freshening the edges, by catgut sutures, leaving a small opening at the lower angle of the wound through which the bladder is drained. Drainage is carried out by inserting a 26 French catheter from the perineal wound through the cyst cavity into the bladder (Fig. 25).

STEP 6.—The vesical and abdominal wounds are closed in anatomical layers. A small cigarette drain is inserted to the space of Retzius.

TOTAL CYSTECTOMY AND EXCLUSION OF THE BLADDER

A. Complete extirpation of the bladder (Tuffier, Watson and Cunningham, 30, Squier).

B. Exclusion of the bladder (Mayo, 18).

In considering total cystectomy as an operation of value, we are forced to consider the mortality incident to such an operation and the postoperative condition of the patient who survives. From the nature of the conditions that call for this operation we naturally expect a large operative mortality and considerable postoperative morbidity. The results of total extirpation of the bladder demonstrate 3 facts very prominently:

1. A primary operative mortality of 40 per cent.
2. An extra mortality of 48 per cent. from direct infection of the kidneys as the result of ureteral implantation.
3. A total eventual mortality of 88 per cent.

From these premises the outlook is not very hopeful under any circumstances.

Watson (30) epitomizes as follows:

(1) The operation must be early, not a terminal event.

(2) Ureteral implantation must be abandoned and a bilateral nephrostomy must be substituted and done as a preliminary step to the operation of total cystectomy. Nephrostomy establishes a permanent renal lumbar fistula, for which the patient wears a special form of apparatus (Watson nephrostomy apparatus).

There are other conditions, however, where the operation of bladder occlusion is necessary, in fact, obligatory.

Mayo groups this class of cases under 3 divisions:

1. *Cases of congenital anomalies of the bladder or urethra of such a character as not to permit the establishment of urinary control.*

2. Cases where portions of the ureter are extirpated or injured during operations undertaken for other conditions.

3. Cases of malignant disease too extensive to permit removal by resection.

Such pathological conditions as render these operations necessary are per se the primary cause of a high mortality. In any procedure, either excision or occlusion, the disposition of the ureters is the fundamental operative consideration. The results of heterotransplantation of the ureter are certainly far from encouraging. The various transplantations are:

1. Entero-anastomosis to appendix, cecum, sigmoid, rectum.
2. Colpo-anastomosis.
3. Implantation of the ureter in the skin (dermato-ureterotresis), either to abdomen or loin (ureterostomy).
4. Nephrostomy.

Total Cystectomy with Ablation of Prostate and Vesicles (Squier).—Total cystectomy can be performed suprapubically with the vertical or transverse incision. The preliminary steps of the operation are as outlined above under subtotal cystectomy. The pathological condition in this class of case will necessitate an extreme peritoneal denudation or excision. Transplantation of the ureters may be done at the time of vesical extirpation, but is best performed as a preliminary operation to total cystectomy. If the operation is to be done in 2 stages, ureteral transplantation should be the first operative procedure.

STEPS 1-7.—Carry out the procedure indicated in the operation for subtotal cystectomy down to and including step No. 7.

STEP 8.—Separate the anterior or pubovesical attachment until the neck of the bladder is exposed and isolated.

STEP 9.—Leave the anterior surface and neck of the bladder for the time being and begin to separate the vesicles and prostate from the rectum, keeping close to the midline and gradually working forward and laterally until the posterior layer of the triangular ligament is reached. The dissection must be carefully carried out to avoid injury to the rectum and, if the vesicoprostatic portion of the operation is left until last, there will be very little hemorrhage from the vesicoprostatic plexus of veins which are particularly abundant about the sides and anterior surface of the prostate.

STEP 10.—Divide the inferior vesical arteries and veins with the ureters, between clamps, preferably using the actual cautery. With curved scissors, cut the bladder, vesicles, and prostate free, immediately behind the posterior lamella of the triangular ligament and remove in toto. Hemostasis is best controlled, temporarily, by large warm compresses firmly packed into the excavation.

STEP 11.—Ligate all bleeding vessels.

STEP 12.—The ureters have been previously attended to or implantation is now performed by transplanting them into the sigmoid or rectum, using the Coffey technic. In order that the terminal portion of the ureter may secure adequate compression of its lumen, the ureter must traverse the wall of the bowel between the muscularis and the peritoneum for a distance of 1 to 1.5 cm., thus preventing dilatation of the ureter with subsequent regurgitation of feculent material into them.

STEP 13.—Close the wound in layers down to the exit of the drainage tubes, as in subtotal cystectomy (page 733).

COMMENT.—This operation is one to be rarely recommended.

ELECTRICAL CAUTERIZATION OF VESICAL NEOPLASMS BY HIGH-FREQUENCY CURRENT

a. Oudin unipolar.

b. D'Arsonval bipolar.

Indications for the use and therapeutic value of the Oudin high-frequency current in the treatment of benign papillomata of the bladder have been established (Beer, 2, 3, 4; Keyes, McCarthy, 19; Thomas, 29; Harris, 8, etc.).

The essential instruments and procedure for this therapy, as outlined by Beer, are:

1. A high-frequency machine (Wappler) with Oudin resonator.
2. A catheterizing cystoscope.
3. A heavily insulated copper electrode.

The Oudin current is derived from the resonator and is unipolar, thus necessitating the use of only one intravesical electrode. After the bladder has been washed and then filled with distilled water, the cystoscope armed with the electrode is introduced. The electrode is pushed a short distance in among the villi of the tumor and the current is allowed to play for 15 to 30 seconds at numerous (10 to 15) points of application, depending upon the size and location of the tumor. If the electrode touches the bladder wall, it causes pain. Treatments are repeated in about 5 to 7 days and are discontinued as soon as the whole growth appears necrotic. The slough is allowed to separate spontaneously or accelerated by bladder irrigations, and in about 2 or 3 weeks will have been definitely cast off when the bladder wall will show a granulating base which should be exposed to the Oudin current as above.

The immediate visible effects of the application are striking. No spark is seen unless the surface is flat and prevents the electrode from burying itself. When the current is on, gas (hydrogen?) is freely generated and bubbles out of the growth.

Beer's conclusions are:

1. All papillary carcinomata should be excluded, as malignant cases do not respond to treatment.

2. Patients intolerant to cystoscopic examination cannot be treated by the transurethral route.

3. A few growths are topographically inaccessible and large growths at

the neck of the bladder are traumatized and bleed so as to prevent accurate work.

McCarthy (19) summarizes the present status as follows:

1. The Oudin spark treatment (cystoscopic) *applies to small or moderate-sized growths, single or multiple, particularly the latter, which are accessible and apparently of a benign character.*

2. *In the absence of a reasonably prompt effect,* such treatment should not be prolonged.

3. Except in the unusual case, where pronounced hematuria obscures the view, the method will supplant the suprapubic operation of excision.

4. The application of the spark should not be made in a cloudy field, as in such event it is inexact and dangerous.

5. Growths of an infiltrating character and with a suspicion of malignancy should be very promptly removed by resection through the entire bladder wall at least 2 cm. beyond the mass, and when in close proximity to the ureteral orifice should include transplantation.

6. In the case of a very great number of outgrowths in the bladder which, while benign, are, from their very multiplicity, not amenable to the spark treatment, one should not forget that this same treatment may with much effectiveness be directed via the suprapubic opening.

POSTOPERATIVE TREATMENT

General Measures.—Regardless of the condition for which the operation has been undertaken, or the method used in the various operative procedures, the postoperative treatment is essentially the same. On account of the age of many of the patients undergoing a bladder operation, certain general or systemic measures are indicated. First and foremost is the condition of urinary excretion; secondly, the tone and stability of the cardiovascular system; thirdly, the avoidance of pulmonary complications; and, fourthly, local measures dealing with urinary drainage and the condition of the wound.

As most of the cases will have had a preliminary injection of morphin, with or without atropin sulphate or scopolamin, the patient is usually quiet for some time after the operation, especially if general anesthesia has been used. Where nitrous-oxid-gas-oxygen anesthesia has been used the patient is usually clearly conscious when returned to bed. The patient's head is slightly elevated and where the operation has been a cystectomy the head of the bed is elevated to a Fowler position of about 35°.

Murphy proctoclysis of plain water is instituted and made continuous for about 48 hours, when 1,000 c. c. of plain water is given night and morning for 2 days. If the pulse is rapid and small in quantity, digalen 0.50 c. c. is given every 4 hours hypodermically. If, however, the pulse is weak and the myocardial sounds poor, spartein sulphate 0.12 gm. is given every 4 hours hypodermically. After the patient has recovered from whatever nausea and vomiting may have occurred incident to the anesthesia, he is given water freely and fluid diet until the bowels have moved, when a soft diet is instituted. During the second day after operation the patient receives sodium benzoate and urotropin, 0.50 gm. of each, in a full glass of water every 4 hours. At the end of 36 to 48 hours the bowels are moved by calomel 0.015 gm. every 15 minutes for 6 doses, to be followed in 12 hours by magnesium sulphate 30 gm. Instead of calomel, castor oil, 30 to 50 c. c., is very often used. If abdominal distention is prominent at any time after operation, we have recourse to enemata; the following in the order of efficacy are used: (1) mag. sulp. 30 gm., glycerin 30 c. c., water 150 c. c.; (2) mag. sulp. 30 gm., glycerin 30 c. c., turpentine 10 c. c., soapsuds 500 c. c.; (3) milk 250 c. c., molasses 250 c. c.; (4) alum pulv. 15 gm., water 500 c. c. In addition to the enemata, eserin salicylate 0.0015 gm. is given every 4 hours hypodermically, or hormonal 1 ampule, or pituritin 1 c. c., hypodermically. Tea, coffee, and alcohol and condiments are interdicted in the dietary.

Local Measures.—When the patient is returned to bed, the drainage tube is connected with a bottle at the side of the bed by flexible rubber tubing. I have not used continuous irrigation or aspiration for some time, and can see no compensating benefit to warrant its use. However, continuous aspiration may readily be instituted by means of the Cathcart T-tube apparatus, or the Bunsen bottles adopted for suction drainage of the bladder. The cigarette drain in the space of Retzius is usually removed before the end of the third day, and the tube in the bladder within a week, except in cases of cystostomy. The sutures are removed on the tenth day, and the skin incision strapped with 2 or 3 narrow strips of sterile adhesive plaster.

When the urine begins to discharge upon the skin, it is necessary to protect it from irritation. I have found that tincture of aloes, applied to the dry skin 3 to 4 times a day, is an efficient means of preventing redness and irritation of the skin. Occasionally, a peculiar change, so-called phosphaturia, takes place in the urine, whereby phosphatic material is deposited in and about the wound. When this occurs, the urotropin and sodium benzoate are omitted, and dilute aromatic sulphuric acid, 2 c. c., is given in a full glass of water every 4 hours through a glass drinking tube. The disposition of phosphates takes place within the bladder, and at about the seventh day considerable sloughs begin to come away from the bladder wall. This condition is best treated by giving aromatic sulphuric acid by mouth and irrigating the bladder with diluted hydrochloric acid of the strength of .2 per cent. in plain water or with a suspension of Bulgarian bacilli. The occurrence of this phosphatic decomposition is not serious, but it delays the convalescence and is an annoying complication.

Bladder cases should be encouraged to get up out of bed early, and after prostatectomy it has been our custom to have them out of bed within a week, and in resection cases, in 10 days to 2 weeks. The bladder is irrigated for the first few days every 4 hours with a warm saline or saturated boric acid solution.

About the fourth day this is usually done twice a day, and at about the end of a week, with 1:1,000 silver nitrate solution daily.

In cases of cystotomy for calculus, or the removal of foreign bodies where the bladder is clean and the surgery slight, without trauma, and when hemorrhage is not present or expected, primary closure of the bladder with a small drain in the space of Retzius is usually successful when combined with catheterization every 4 hours. If leakage occurs in the suprapubic wound, no trouble is to be anticipated, as it usually clears up very readily.

Complications.—The complications that may be expected are seriatim, shock, hemorrhage, suppression of urine, infection, pelvic cellulitis, epididymitis, phlebitis, abscess, rarely extravasation into the paravesical tissues, peritonitis, surgical kidney, permanent fistula, and incontinence of urine. These are to be treated according to accepted surgical principles.

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CANCER OF THE RECTUM AND SIGMOID

CHAPTER XVI

CANCER OF THE RECTUM AND SIGMOID

JEROME M. LYNCH

INDICATIONS FOR OPERATION

Surgery, so far as our knowledge goes, offers the only hope of a cure in cancer. Cancer of the rectum and sigmoid is no exception to this rule. Even in far advanced cases, a local removal of the growth, either by the cautery or the knife, gives at least temporary relief. After complete removal over 40 per cent. of the cases in the practice of our late colleague, Dr. Tuttle, and in my own series, were reported cured 3 years after operation. Fortunately for the patient, cancer of the rectum and colon, the anus being excepted, remains stationary for a long period, but unfortunately many cases, that to the uninitiated are inoperable, are saddled with an artificial anus plus the growth when they might be temporarily or permanently relieved by a radical operation. An operation is contra-indicated when the liver is involved or when the tumor has so encroached on neighboring organs as to render it impossible to restore their functions after the removal of the cancer. Recently, under a more perfected technique, with careful preparation and blocking of the sympathetic, combined with sacral anesthesia, we are operating and getting good results in some cases that we would have considered inoperable several years ago. In a last series of 16 consecutive cases since the first of October, we have lost 3. We had 10 consecutive cases without any mortality, all combined operations, some of the cancers fairly well advanced.

We have observed that constipation is the earliest symptom of cancer, that this is probably due to some enzyme or toxin secreted by the cancer and having a selective action on Auerbach's plexus. It is extremely difficult, even with the aid of cathartics and enemas to satisfactorily empty the bowel of a cancer patient. In most cases, even though the caliber of the gut is not diminished, the growth being a lateral one, there is always an accumulation above the tumor. It is also worth recording that very frequently after the operation when the continuity of the bowel has been restored, there is increased peristalsis and, indeed, in some cases a diarrhea; but after a while this adjusts itself and the bowel functionates normally. We have observed, more than once, that when patients had a recurrence the first symptom was constipation, and they noticed this themselves. In more than 1 instance the new growth was not larger than the end of the thumb, yet it had begun to manifest itself by constipation. Quite the opposite occurs in some cases where the bowel is resected for benign tumors or inflammatory conditions. Not infrequently in such cases, the constipation continues after the resection. This is due, we think, to the destruction of Auerbach's plexus by an inflammatory process.

In discussing the operative treatment of tumors of the cecum and colon, Dr. E. M. Corner, at a meeting of the Medical Society of London, October, 1914, stated that he had gleaned from the records of St. Thomas's Hospital (London) this interesting data that the incidence of obstruction was as follows:

Carcinomata of the cecum, 4.1 per cent.; carcinomata of the ascending colon, 0.7 per cent.; carcinomata of the hepatic flexure of the colon, 2.5 per cent.; carcinomata of the transverse colon, 13.4 per cent.; carcinomata of the splenic flexure of the colon, 17.4 per cent.; carcinomata of the descending colon, 5.1 per cent.; and carcinomata of the iliac and pelvic colon, 59.8 per cent. These figures showed that: (1) Carcinomata of the cecum, and still more carcinomata of the ascending colon, did not seem to obstruct the intestinal flow. The growth tended to be lateral and local in the gut wall, like carcinomata of the rectum; hence they did not obstruct the flow within the bowel as did a ring growth. (2) Carcinomata of the iliac and pelvic colon, splenic flexure, and transverse colon were quite different in their clinical behavior, causing intestinal obstruction early in their course. (3) Carcinomata of the splenic flexure were infrequent, but practically always caused intestinal obstruction. Carcinomata of the hepatic flexure showed the same feature to a much marked degree. Since many regarded the whole of the large intestine as an anatomical unity, it might as well be included amongst the carcinomata, those of the rectum in the statistics showing the relative importance of the carcinomata of the large intestine in causing acute intestinal obstruction. Including these the figures were: Carcinoma of the cecum, 3.3 per cent.; carcinoma of the ascending colon, 0.2 per cent.; carcinoma of the hepatic flexure of the colon, 1.7 per cent.; carcinoma of the transverse colon, 11 per cent.; carcinoma of the splenic flexure of the colon, 14.3 per cent.; carcinoma of the descending colon, 4 per cent.; carcinoma of the iliac and pelvic colon, 47 per cent.; and carcinoma of the rectum, 18.5 per cent. It would be seen that the asymmetrical and "lumpy" as contrasted with the symmetrical and annular carcinomata of the right side segment of the colon were the least liable to cause acute intestinal obstruction. This clinical condition increased in frequency when the growth was in the transverse colon, at the splenic flexure, to reach its maximum clinical incidence in the iliac and pelvic colon, where it took the form of a ring like band (from the disposition of the lymphatics) constricting the bowel. In the rectum, again, the growth was "lumpy" and asymmetrical in its disposition.

It would be seen that, looked at from all points of view, carcinomata of the transverse colon occupied both pathologically and, to a less degree, clinically, an intermediate position between cecal and sigmoid carcinomata; whilst in cases of acute intestinal obstruction where the situation of the cause could not be ascertained, the preponderance of the left side causes over those on the right side suggested the very practical point of opening the abdomen through the left rectus muscle. Clinically carcinomata of the transverse colon exhibit these characteristics: The absence of warning to the patient, the unannounced onset of acute intestinal obstruction, and the presence of a small annular growth. Hence, when it came to treatment the surgeon had 2 things to attend to—intestinal obstruction primarily and a carcinoma of the transverse colon secondarily. The former was a condition in which myriads of microörganisms abounded. The organisms were responsible for many and much of the surgical failures in removal of growths from the colon. Hence he would urge that the surgeon was very unsound who attempted to do constructive work, e. g., the plastic work of an anastomosis in the face of this sepsis. Therefore, when any degree of acute intestinal obstruction was present, a temporary colostomy alone should be done. The artificial anus and the growth should be removed about a fortnight or 3 weeks later, the ends of the resected bowel sutured and closed, and the cecum anastomosed to the sigmoid. It was noteworthy that it was strongly advised that the surgeon should do nothing, not even with removal of the growth, but relieve the intestinal obstruction. In the speaker's experience patients so treated did better in both their early and late clinical postoperative stages than if the growth was removed and the Paul's tubes inserted. It was far better to leave the resection of the growth until the time of the anastomosis. An inflamed growth was far more likely to lead to trouble if any attempt was made to remove it than was an uninflamed growth.

In the practice of the late Dr. James P. Tuttle and myself a series of 168 operations for cancer of the large bowel presents the following data. We hope in the near future to be able to settle definitely the number of cases operated on that are alive to date; so far we can account for only 56 out of the 130 recoveries.

	Cases operated	Recoveries	Deaths
Adenocarcinoma	144	106	37
Epithelioma	5	5	
Sarcoma	7	7	
Colloid carcinoma	2	2	
Scirrhous carcinoma	2	2	
Malignant papilloma	6	6	
Malignant condyloma ...	1	1	
Malignant stricture	1	1	
Totals	168	130: 77 per cent.	37: 22 per cent.

Preparation of the Patient.—Preparation of the patient for operation is as important as the after-treatment; often the success of the operation depends upon the proper preparatory care. Unless contra-indicated, our usual procedure is to administer calomel in broken doses 3 or 4 days previous to operation. This is followed by a saline cathartic and subsequently by castor oil. At the time of operation the bowel is irrigated with a 2 per cent. solution of peroxid of hydrogen and methylene blue. This has a decided cleansing effect and also the advantage of breaking up any hard fecal matter that may have accumulated. Twenty-four hours before operation the bowels are tied up by administering deodorized tincture of opium in doses of 10 minims 3 times a day; then 2 hours before the operation 1/4 of morphin and 1/150 of atropin is administered hypodermically; and 1/2 an hour before, if the patient is not well under the influence of the drug, we administer 1/8 or 1/16 of morphin.

The technique for sacral anesthesia is as follows:[1]

> The point at which the needle is to be inserted is first decided upon. This can be determined by following the sacral, spinous processes until they are found lacking. Slightly above this point will be found the opening of the canal. If, as happens in most cases, we have a bifid spine, the ridges can easily be felt, except, as I have said, in very fat subjects. If the canal opens near the sacrococcygeal joint, this point is selected. Then, having first determined the point at which the needle is to be inserted, and this is always in the median line, it is painted with tincture of iodin. Next, a little ethyl chlorid is sprayed on the skin, and a hypodermic syringe, containing a solution of 1 to 500 novocain, with an ordinary hypodermic needle, is employed in order to anesthetize the skin over the area in which the needle is to be inserted, so that a small incision can be made without causing any pain. It is always better to incise the skin in order to obviate any chance of infection.
>
> The following procedure is used in passing the needle: The needle is grasped in the right hand, and the index finger placed close to the point. It is then passed at an angle of 15° until the bone is reached. The needle is then passed close to the bone until it has been entirely inserted for about one inch. At this juncture it is well to pause and make sure whether the needle is in the canal or not. This can be determined, as was said above, by moving the needle back and forth, up and down, and from side to side. If it is in the canal, the wall will be found on all sides, and if it is not, the needle will readily pass through the skin.
>
> If the needle is found to be in the canal, about four c. c. of the same solution is deposited on both sides. This is usually sufficient.
>
> After this has been done the trocar is reinserted in order to prevent the escape of fluid, and the needle, with the trocar, allowed to remain in position until anesthesia is established. The reason for this is that if anesthesia is not established after 15 minutes, it may be necessary to inject 1 or 2 c. c. more, and this is made much simpler if the needle has been left in place. It is important, first, for the fluid to be absolutely sterile, and of the same specific gravity as the blood in order that it may be readily absorbed.
>
> After anesthesia has been established the needle is withdrawn, and some cotton and collodion placed over the wound. The patient is then placed in whatever position is desirable in order to perform the operation, and the rest of the procedure depends on what particular operation has been undertaken. If a prolonged anesthesia is necessary, urea and quinin may be substituted for novocain. I have not as yet determined how much of the urea and quinin is necessary in order to produce complete anesthesia, or what would be the duration of the anesthesia under this process.

Perineal Operation.—The patient is placed in the lithotomy position. The lower bowel is irrigated with pure peroxid, and, if after irrigation there is danger of leakage, some sterile gauze is packed in the rectum. An incision is made in the posterior commissure between the mucous membrane and the skin. The mucous membrane is then dissected all around as in a Whitehead operation and held in position with T-forceps. To prevent any further soiling of the wound the mucous membrane is tied either with purse string or an ordinary suture. The muscle is slit posteriorly and the incision is continued until the sacrococcygeal joint is reached. The levator muscle is divided with a knife and the index finger passed into the opening and above the muscle, which is separated from the bowel with a scissors; the finger is swung around to the right side, and the same process repeated (Fig. 1). The sphincter muscle may or may not be slit anteriorly. However, before separating the rectum from the urethra and prostate a sound should be passed into the bladder, after which a careful dissection is made with the scissors until the line of cleavage is reached. Great care should be exercised at this juncture not to pull on the rectum, because by so doing the urethra is kinked and one may incautiously remove a portion of it. When dissecting the rectum free from its anterior connections, it should be pulled out and not backwards. Once the line of cleavage is reached the rest of the operation is comparatively simple. We should sound a note of warning against unnecessary pulling or dragging on the bowel at any period. The entire operation should be a free, clean dissection, as nothing is gained by using force. After the peritoneal reflection is reached, the vas deferens occasionally comes into view and may be mistaken for the ureter. It is not always necessary to cut the vas, but if it should be cut accidentally it is not of very great moment. After the anterior dissection has been completed as in Fig. 2, the lateral ligaments should be double clamped and cut between the clamps. The peritoneum as it spreads out above the lateral ligaments should be severed. The operator now holds the rectum forward and outward with his left hand, and with the right gently separates the rectum from the sacrum. When this has been accomplished the bowel ought to come down with little difficulty.

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[1] Lynch: Diseases of the Rectum and Colon.

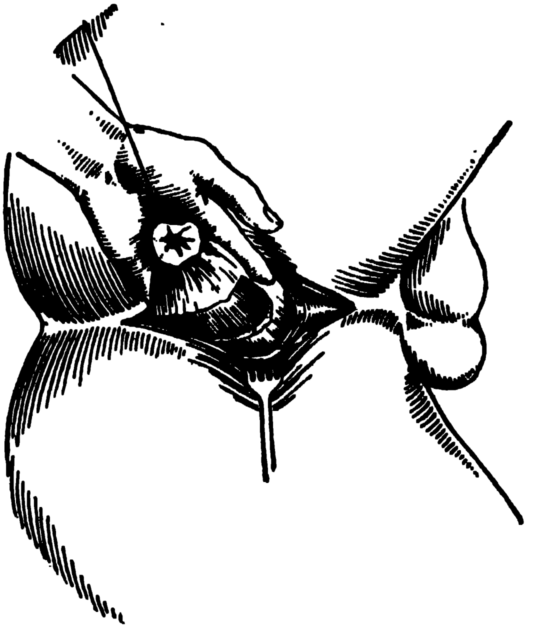

FIG. 1.—PERINEAL EXTIRPATION. Loosening Rectum from Levator Ani and Anterior Raphe.

Any other slight attachments should be divided between the clamps. It is not necessary to tie the lateral ligaments; if the clamps are allowed to remain in place for ½ hour, they can then be removed with very little danger of hemorrhage occurring subsequently. The bowel is now brought down with the tumor outside of the perineum and with it the healthy gut. One should be absolutely sure to remove the bowel several inches above the growth. Whenever possible the bowel above the growth should be amputated by a cautery. The bowel having been brought down without tension the operator closes the anterior opening by attaching the peritoneum to the healthy gut with 3 or 4 interrupted catgut sutures. All dead spaces should be closed in the same manner, and the bowel attached to the levator ani muscle by interrupted sutures. It is our custom to place a drainage tube in the posterior space and around this to pack some gauze. The sphincter muscle is next approximated by sutures and the musculature of the bowel attached by 1 or 2 interrupted sutures on either side to the musculature. The mucous membrane and the skin are then approximated by catgut sutures.

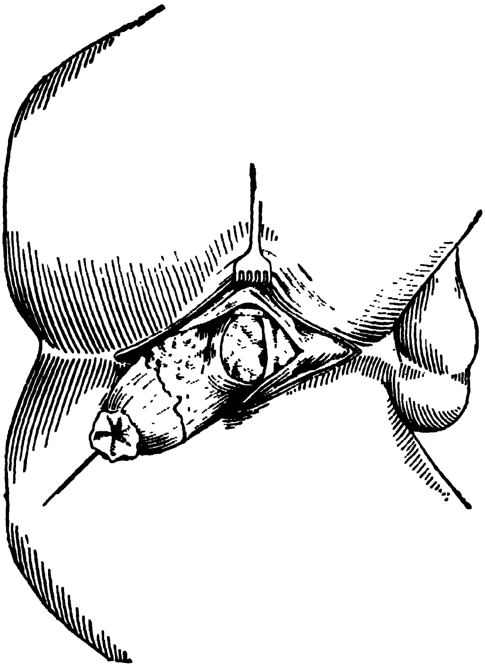

FIG. 2.—PERINEAL EXTIRPATION. Showing the Culdesac opened in the perineal operation.

Combined Operation.—The combined operation in a stout patient is extremely difficult, therefore, it is imperative to make a large incision. Our preference is for a median incision, continued to 1 side or the other of the umbilicus, and large enough to allow sufficient room, so that the surgeon can work uninterruptedly and see what he is doing. After the abdomen has been opened a self-retaining retractor is adjusted in place and the patient is then put in the Trendelenburg position. It is most important that all the small bowels should be thoroughly walled off, so that when the table is lowered they do not fall back into the pelvis. The sigmoid is brought out of the wound, and in so doing tension is put on the sigmoidal vessels. This is important as indicating the blood vessels which are to be tied. The right leaf of the mesenteric peritoneum is slit, and a scissors curved on the flat passed through the opening. This instrument can be passed for a considerable distance. By gently opening the blade the peritoneum is separated from the fat and blood vessels, and is then cut with a knife, using the scissors as a director. The left leaf is treated in the same manner, as far as the culdesac. Here a transverse incision connects the 2 longitudinal openings (Fig. 3). The sigmoidal arteries are ligated close to the root of the mesentery. A little below the sigmoidal vessels, as the bowel passes over the promontory of the sacrum, the superior hemorrhoidal artery can be found, and it also is ligated, after which the bowel can be dissected out from between the 2 leaves of the mesentery, carrying with it all fat and glands. This dissection is continued to the levator ani by means of a periosteal elevator or a scissors. The bowel is separated in front from the vagina in the female and from the prostate and urethra in the male. The lateral ligaments should be double clamped, otherwise severe bleeding may result from cutting the middle hemorrhoidal arteries (Fig. 4).

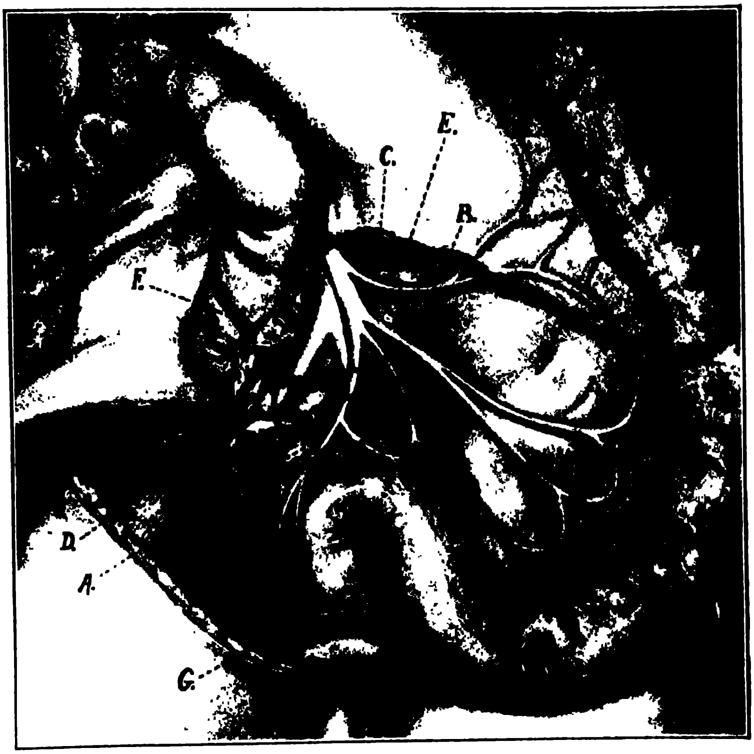

FIG. 3.—COMBINED OPERATION FOR CANCER OF THE RECTUM, showing the method of stripping the peritoneum previous to tying off the blood supply.

From now on there is some difference in technique, depending to a great extent on whether the surgeon proposes to eradicate the lower segment and leave the patient with an artificial anus, or whether he intends to remove the lower segment and bring the sigmoid down to take its place.

If the first is to be carried out, the bowel is double clamped and divided below the peritoneal reflection. This division is always to be accomplished with the cautery or with a Pryor clamp. After the bowel has been divided, the lower segment is invaginated and closed by a purse-string suture. The upper segment is treated in the same way, covered over with a cloth and brought outside of the abdominal wall. The operator now proceeds to close the peritoneal floor, and, for this purpose, the peritoneum that has been dissected from the mesenteric leaves is used (Fig. 5). The peritoneum is closed so that no raw surfaces are left. The abdomen is closed in the usual manner except that the peritoneum is stitched to the oral end of the bowel, and the fascia is closed by interrupted sutures. The skin is closed by interrupted silkworm-gut sutures.

The surgeon can now return the patient to bed and divide the operation into 2 stages, removing the cephalad end at a subsequent operation, or the patient can be put in the lithotomy position and the cephalad removed at the same sitting. The technique for this is very simple, because it is not necessary to save any of the structures. A wide incision is made around the anus, about an inch from the opening, and all the glands and surrounding skin are removed by this incision.

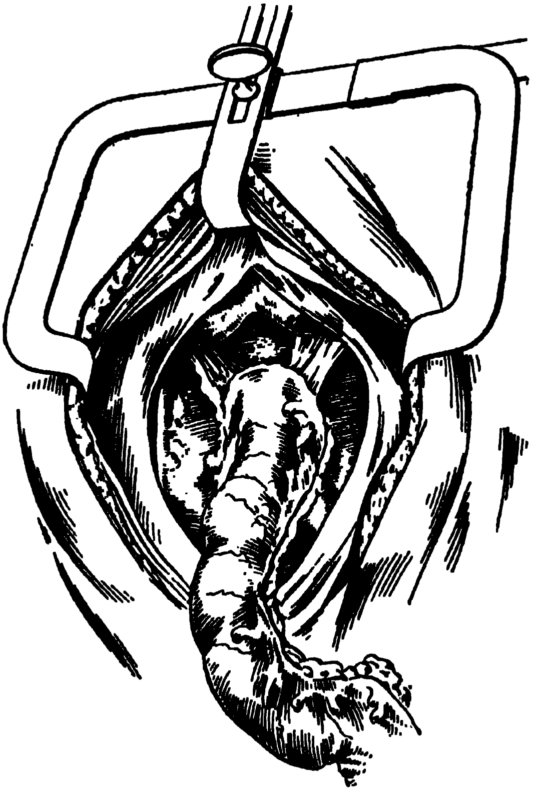

Fig. 4.—Combined Operation Showing Lateral Ligaments.

The dissection is continued up to the levator muscle. Here an opening is made posteriorly in the muscle, and the surgeon passes the left index finger through the opening, bringing it forward on the left side close to the gut where the levator ani is attached. Using the finger as a director, the operator separates the levator ani muscle from the bowel. Then this same finger is passed over on the right side where the same procedure is carried out. The lateral ligaments are double clamped and cut. After this the entire lower bowel is removed. A drainage tube is passed into the cavity, and around this is packed some gauze. The levator muscle and its fascia are brought together by interrupted sutures and the skin is treated in the same manner. The posterior incision should now be prolonged to the side of the coccyx, as far as the dissection with the sacrum, and the wound closed, leaving an opening sufficiently large to allow for the removal of the gauze and the drainage tube. By continuing the incision posteriorly, we reach the most dependent portion of this large cavity and establish efficient drainage in this way.

In the second method of procedure, the operator dissects the bowel free from its mesentery and from the vagina in the female, and from the prostate in the male, and posteriorly as far as the levator muscle. One of 2 methods can be followed: The assistant makes an incision between the rectum and the coccyx, continuing it if necessary to the sacrococcygeal joint afterwards separating the levator muscle. Through this opening the forceps is passed, a piece of gauze or tape tied around the bowel above and the ends of the tape placed between the jaws of the clamp which has been passed up from below. The clamp is now withdrawn and with it the bowel, which is brought out through the posterior incision. The operator closes the peritoneal floor and afterwards the abdominal cavity. In the other procedure the bowel is packed down into the pelvis and a new diaphragm made about an inch above the old one, and the abdomen closed. The patient is now placed in the Trendelenburg position and the anus closed by means of a purse-string suture. The mucous membrane is dissected free from the skin, as in a Whitehead operation, and the sphincter muscle slit posteriorly, the levator muscle separated from the bowel, and the tumor with the lower bowel brought through this opening, until healthy bowel is reached. Here the bowel is double clamped and cut through by means of a cautery, care being taken to tie the blood vessels at the mesenteric border. The levator muscle is attached to the gut with 2 or 3

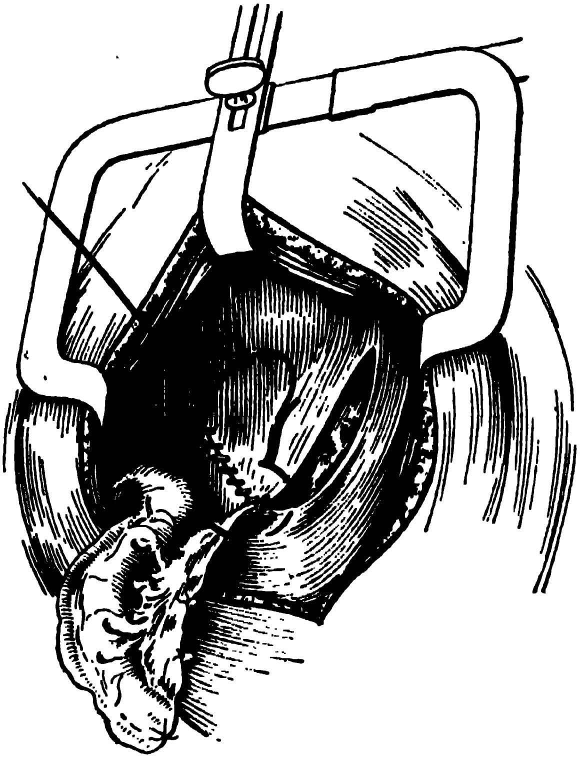

Fig. 5.—Combined Operation Closing Peritoneal Floor after Dividing the Bowel.

interrupted sutures, and over this the fascia is sutured snugly around the bowel. The 2 ends of the divided sphincter should be brought together with catgut sutures and afterwards the skin with silkworm-gut sutures. The next step consists in sewing the mucous membrane to the skin and around the anus. When this is completed a drainage tube is placed in the rectum. Into the cavity back of the rectum, a small drainage tube is passed and some fluffed gauze packed in to prevent oozing. The posterior incision should be continued back to the site of the coccyx so that drainage may be established at the dependent point.

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